PRELIMINARY

VORTEX II

REFERENCE MANUAL

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FOREWORD

This manual explains the **Varian Omnitask Real-Time Executive** (**VORTEX**) and its use, but it is not intended for a beginning audience. Prerequisite to an understanding of this manual is a knowledge of general programming concepts, and preferably some Varian Data Machines 620 series or V70 series computer system is desirable.

NOTATION IN THIS MANUAL

In the directive formats given in this manual:

- **Boldface type** indicates an obligatory parameter
- *Italic type* indicates an optional parameter.
- Upper case type indicates that the parameter is to be entered exactly as written.
- Lower case type indicates a variable and shows where the user is to enter a legal value for that variable.

a(1),a(2),...,a(n).

Indicates a series of elements separated by commas repeated and terminated with a period.

If at least one element is required the first element is given in bold. The parentheses are only part of the format description.

For example

a(1),*a(2),...,a(n)*.

where

each a(i) is a single alphabetic character allows

A,B,C,F,G,H.

or

Z,Y,X.

or

V.

or

blank

as valid in this position.

A number with a leading zero is octal, one without a leading zero is decimal, and a number in binary is specifically indicated as such.

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SECTION 1
INTRODUCTION

The Varian Omnitask Real-Time EXecutive (**VORTEX II**) is a modular software operating system for controlling, scheduling, and monitoring tasks in real-time multiprogramming environment. VORTEX II supports memory map operation to a maximum of 256K of central memory. VORTEX II also provides for background operations such as compilation, assembly, debugging, or execution of tasks not associated with the real-time functions of the system. In addition, VORTEX II supports user tasks using the V75 extended instruction set. Thus, the basic features of VORTEX II comprise:

- Memory map management
- Real-time I/O processing
- Provision for directly connected interrupts
- Interrupt processing
- Multiprogramming of real-time and background tasks
- Overlapping output to peripherals with spooling
- Priority task scheduling (clock time or interrupt)
- Load and go (automatic)
- Centralized and device-independent I/O system using logical unit and file names
- Operator communications
- Batch-processing job-control language
- Program overlays
- Background programming aids FORTRAN and RPG IV compilers, DAS MR assembler, load-module generator, library updating, debugging, and source editor.
- Use of background area when required by foreground tasks
- Disc/drum directories and references
- System generator
- Individual task protection

NOTE: Throughout this manual, all references to VORTEX imply VORTEX II.

1.1 SYSTEM REQUIREMENTS

VORTEX requires the following minimum hardware configuration:

a. Varian V70 series computers with 32K memory

b. 33/35 ASR Teletype or compatible CRT on a priority interrupt module

c. Priority Interrupt Module (PIM)

d. Rotating memory device (RMD) on a PIM with either a buffer interlace controller (BIC) or block transfer controller (BTC)

e. One of the following on a PIM:
   (1) Card reader with a BIC
   (2) Paper-tape system or a paper-tape reader
   (3) Magnetic-tape unit with a BIC

f. Memory map hardware

The system supports and is enhanced by the following optional hardware items:

a. Additional main memory (up to a total of 256K)

b. Additional rotating memory devices

c. Automatic bootstrap loader with VORTEX II (device dependent) system boot

d. Card reader, if one is not included in the minimum system with BIC and PIM

e. Card punch with BIC and PIM

f. Line printer with BIC and PIM

g. Paper-tape punch, if one is not included in the minimum system

h. Process input and output

i. Data communications multiplexor

j. Electrostatic printer/plotter

k. Writable control store

l. Floating-point processor

m. V75 extended instruction set.

All BICs, BTCs, and DCMs must have memory mapping capability.

The rotating-memory device (RMD) serves as storage for the VORTEX operating system components, enabling real-time operations and a multiprogramming environment for solving real-time and nonreal-time problems. Real-time processing is implemented by hardware interrupt controls and software task scheduling. Tasks are scheduled for execution by operator requests, other tasks, device interrupts, or the completion of time intervals.

Background processing (nonreal-time) operations, such as FORTRAN compilations or DAS MR assemblies, are under control of the job-control processor (section 4), itself a VORTEX background task. These background processing operations are performed simultaneously with the real-time foreground tasks until execution of the former is suspended, either by an interrupt or a scheduled task.

1.2 SYSTEM FLOW AND ORGANIZATION

VORTEX executes foreground and background tasks scheduled by operator requests, interrupts, or other tasks. All tasks are scheduled, activated, and executed by the real-time executive component on a priority basis. Thus, in the VORTEX operating system, each task has a level of priority that determines what will be executed first when two or more tasks come up for execution simultaneously.

The job-control processor component of the VORTEX system manages requests for the scheduling of background tasks.

Upon completion of a task, control returns to the real-time executive. In the case of a background task, the real-time executive schedules the job-control processor to determine if there are any further background tasks for execution.

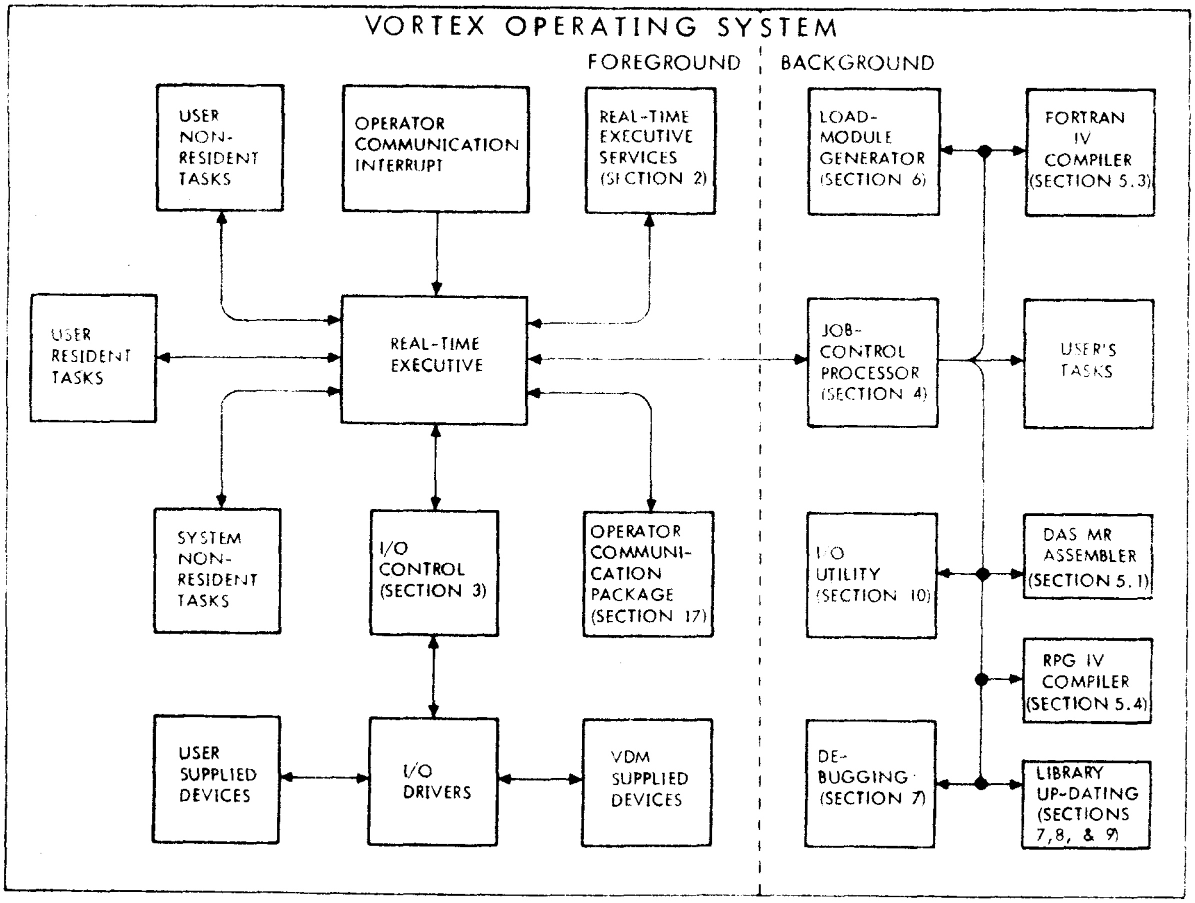
During execution, any foreground task can use any real-time executive service (section 2.1).

Figure 1-1 is an overview of the flow in the VORTEX operating system. Section numbers refer to further discussion of this manual.

1.2.1 Computer Memory

VORTEX requires a minimum of 32K words of main memory and supports up to a maximum of 256K words.

The system generation (SGEN, section 15) programs execute in a non-memory map environment and consequently utilize only the first physical 32K words of main


VORTEX OPERATING SYSTEM
FOREGROUND
BACKGROUND
USER NON-RESIDENT TASKS
OPERATOR COMMUNICATION INTERRUPT
REAL-TIME EXECUTIVE SERVICES (SECTION 2)
LOAD-MODULE GENERATOR (SECTION 6)
FORTRAN IV COMPILER (SECTION 5.3)
USER RESIDENT TASKS
REAL-TIME EXECUTIVE
JOB-CONTROL PROCESSOR (SECTION 4)
USER'S TASKS
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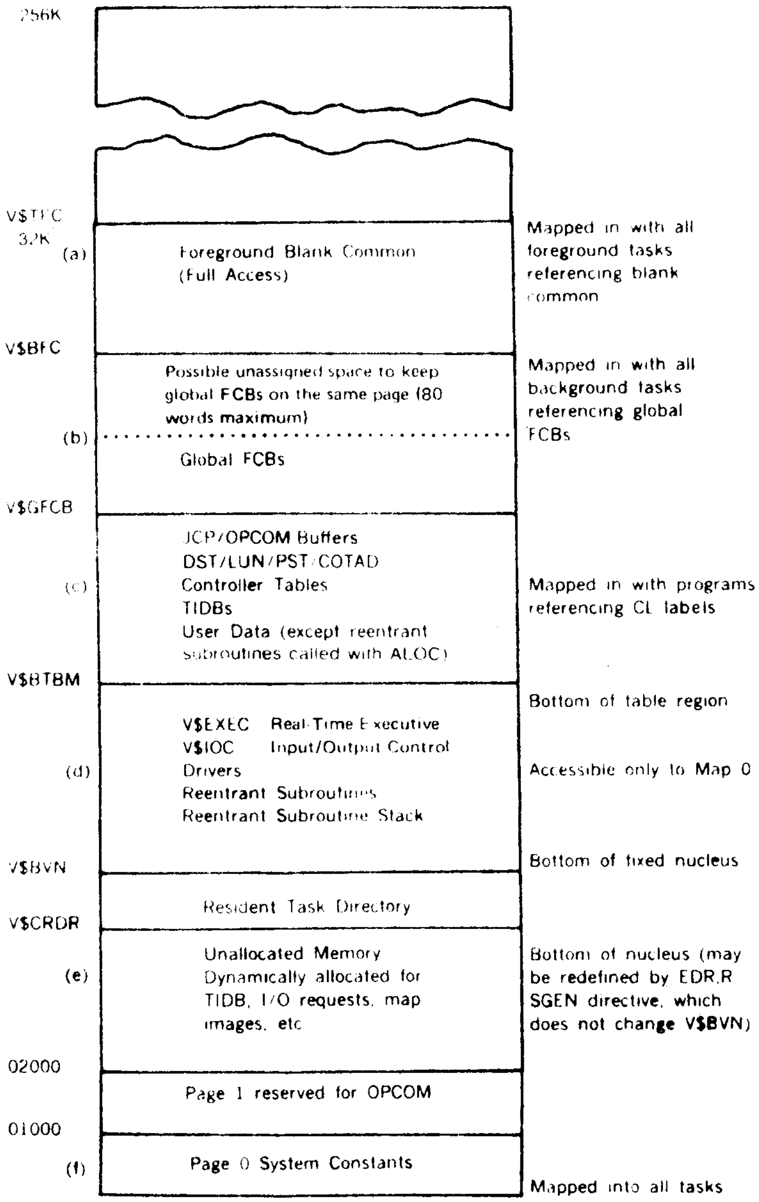
OPERATOR COMMUNI-CATION PACKAGE (SECTION 17)
I/O UTILITY (SECTION 10)
DAS MR ASSEMBLER (SECTION 5.1)
RPG IV COMPILER (SECTION 5.4)
USER SUPPLIED DEVICES
I/O DRIVERS
VDM SUPPLIED DEVICES
DE-BUGGING (SECTION 7)
LIBRARY UP-DATING (SECTIONS 7,8, & 9)

VTII-1314

Figure 1-1. VORTEX System Flow


256K
V$TFC
32K
(a)
Foreground Blank Common
(Full Access)
Mapped in with all foreground tasks referencing blank common
V$BFC
Possible unassigned space to keep global FCBs on the same page (80 words maximum)
(b)
Global FCBs
Mapped in with all background tasks referencing global FCBs
V$GFCB
JCP/OPCOM Buffers
DST/LUN/PST/COTAD
(c)
Controller Tables
TIDBs
User Data (except reentrant subroutines called with ALOC)
Mapped in with programs referencing CL labels
V$BTBM
Bottom of table region
V$EXEC Real-Time Executive
V$IOC Input/Output Control
(d)
Drivers
Reentrant Subroutines
Reentrant Subroutine Stack
Accessible only to Map 0
V$BVN
Bottom of fixed nucleus
Resident Task Directory
V$CRDR
Unallocated Memory
(e)
Dynamically allocated for TIDB, I/O requests, map images, etc
Bottom of nucleus (may be redefined by EDR,R SGEN directive, which does not change V$BVN)
02000
Page 1 reserved for OPCOM
01000
(f)
Page 0 System Constants
Mapped into all tasks

NOTE: TSK defined resident tasks are loaded upward from physical address 02000 in the first physical 32K of memory by SGEN. However, the resident tasks are not mapped in Map 0 but in a user map (1-15) as the resident tasks are scheduled. The physical page numbers defining the resident tasks are contained in the resident directory (V$CRDR).

NOTE: VTFC, VBFC, etc. are system pointers in page 0 described in section 14, table 14-1.

NOTE: V$TFC, top of nucleus, is specified on SGEN MRY directive (described in section 15.5.1).

Figure 1-2. VORTEX Nucleus, Map 0

memory. All resident tasks and data reside in the first 32K of memory. Except for those resident tasks defined by the SGEN TSK directive, all other resident tasks and data are considered as part of the VORTEX nucleus. The nucleus is assigned to be in the executive mode, map 0, virtual memory (see section 1.3).

Figure 1.2 illustrates the map 0 nucleus memory layout. The 32K words memory space is grouped into several modules:

a. Foreground Blank Common Module: This module is mapped with all foreground tasks referencing blank common.

b. Global FCB Module: This module is mapped with all background tasks referencing the global FCBs. It is read only access mode for priority 0 tasks and read/write for priority 1 tasks. This module is of approximately 90 words.

c. Nucleus Table Module: This module is mapped with all tasks with an external name defined in the CL library. Read only access mode for priority 0 tasks and read/write access for all other tasks. The bottom of this module is defined in V$BTBM and is determined by SGEN during the nucleus module building. Control record CTL,21 specifies the end of the nucleus table module. All user data and programs which are to be included in this module must precede the CTL,21 control record. The approximate size of this module is 1000 words (RMD, line printer, card reader, Teletype, CRT).

d. Nucleus Programs Module: This module consists of V$EXEC, V$IOC, I/O drivers, reentrant subroutines, stacks, and any user programs inserted between the CTL,21 and CTL,PART0003 SGEN tasks. The bottom of this module is defined by V$CRDR. The approximate size of this module is 6800 words (RMD, line printer, card reader, Teletype, CRT drivers).

e. Map 0 Allocable Memory Space: The virtual memory space between page two and V$CRDR is available for dynamic allocation. I/O request block, TIDB block, and map image memory space are allocated in this region. Page one is reserved for the OPCOM task. The actual physical memory assigned to the virtual memory space is memory management performed by the RTE component.

f. Page 0: Always reserved for system constants, interrupt traps, and background literal pool (a description is found in section 14, table 14-3).

The unused physical memory in the first 32K and all physical memory above 32K are designated as allocable memory. This is the physical memory which is dynamically allocated for map 0 memory space as described in e. and which is allocated to a user mode task's logical memory.

1.2.2 Rotating Memory Device

At least one RMD (disc or drum) is required for storage of VORTEX operating system components. The RMD is divided into a fixed number of variable-length areas called **partitions**. These are defined at system-generation time (section 15).

The following reside on the RMD (figure 1-3):

a. System initializer, loader, and VORTEX nucleus in absolute format

b. Checkpoint file

c. GO file

d. User library

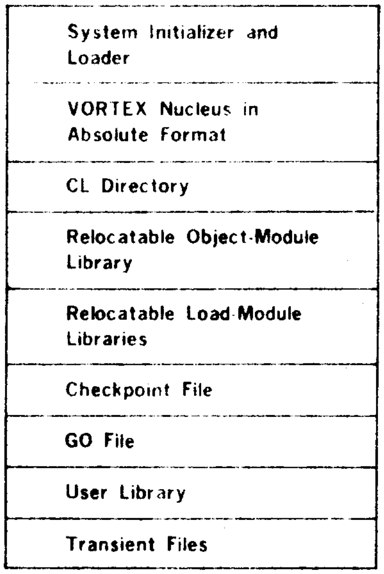
e. Transient files

f. Relocatable object-module library

g. Relocatable load-module library

1.2.3 Secondary Storage

The VORTEX operating system supports any secondary storage devices that have been specified at system generation time.



System Initializer and Loader

VORTEX Nucleus in Absolute Format

CL Directory

Relocatable Object-Module Library

Relocatable Load-Module Libraries

Checkpoint File

GO File

User Library

Transient Files

Figure 1-3. VORTEX RMD Storage Map

1.3 MEMORY MAP CONCEPT

VORTEX logical (virtual) memory is defined to be 32K words. This is the maximum memory space that any single task can address, even though the physical memory space may be as great as 256K words. Where in actual or physical memory that task resides is transparent to the task and is a memory management function performed by the RTE component of VORTEX.

Each logical memory space (32K) is organized into fixed-size blocks of 512 words (01000 in octal), called logical (virtual) pages. Hence, there are 64 logical pages within a 32K logical memory space. The size of the logical memory available to a task is reduced by:

a. Page 0: The first page of 512 words is reserved for system constants, interrupt trap locations, background literal pool and communication link for IOC and V$EXEC calls. This page is mapped in all logical memories.

b. Nucleus Modules: A task referencing an external name which is defined in the CL library will have the corresponding VORTEX nucleus module mapped in logical memory for a task. (Section 1.2.1 describes in greater detail the nucleus modules.) These are:
   (1) Foreground blank common module
   (2) Global FCB module, and/or
   (3) Nucleus table module

c. Any FORTRAN program performing input/output operation will have the nucleus table module mapped into its virtual memory. FORTRAN runtime package requires access to the device specification table (DST), logical unit tables (LUT), and controllers tables for linking information. The maximum available logical memory space available is V$BTBM (bottom of nucleus table module, location 0331) minus 01000 (program start logical address). V$BTBM is defined on the SGEN listing.

d. For background priority 1 tasks, page 0 is set to read/write access mode to permit tasks, e.g., JCP, to modify low memory pointers V$JCFG, V$CRDM, etc. Hence, the method of transferring control from user mode to executive mode for I/O and RTE calls is to map in the pages containing the entry to V$IOC (I/O calls), V$EXEC (RTE calls), and V$IOST (STAT calls). Therefore a priority 1 task making an I/O call (or RTE call, or STAT call), executes a JSR,X to location 0404. Because page 0 is set to read/write access mode, the instruction at 0404 (JMP V$IOC) is executed. The first instruction in V$IOC (likewise, V$EXEC and V$IOST) is a disable PIM (EXC 0444) instruction. Execution of an I/O type instruction in the user map generates a memory-protection interrupt, which forces the system to the executive mode and hence the means of transferring control to the map 0 tasks. Therefore, the available memory space for a background task is from location 01000 to the page where V$IOC (which is lower in memory than V$EXEC) resides. V$IOC address is defined on the SGEN output listing.

All user mode tasks are loaded from logical address 01000. A task not referencing external names defined in the CL library has all of the logical memory available to it except page 0.

Physical memory is also organized into fixed-size blocks of 512 words, referred to as physical pages. A system with physical memory size of 256K words contains 512 physical pages (64 physical pages for each 32K words of memory).

Allocation of logical memory to physical memory is accomplished by pages. A task of 010000 (4096 in decimal) words will reside in eight physical pages of physical memory. These physical pages need not be contiguous. However, that fact is transparent to the task. During execution, the task assumes that its eight pages are contiguous. The linking of physical pages is performed by the memory map hardware. All user program object modules are assembled relative to location 0. Load modules are generated by SGEN and LMGEN to be relative to logical address 01000.

A map defines the 64 logical pages within a logical memory. Each logical page can be set to one of four possible access modes:

Unassigned	The logical addresses within that virtual page are unassigned.
Read/Write	All accesses including write operation permitted to/from the logical page.
Read Operand Only	Only operand fetches permitted from the logical page.
Read Only	Only instruction or operand fetches permitted within the logical page.

Each logical page, except for the pages with unassigned status, must be assigned to a physical page. The RTE task sets the status for each page, allocates a physical page to each logical page, and loads the corresponding mapping registers.

The memory map hardware provides a 4-bit map register for the 16 possible maps. This 4-bit map register is set by the RTE component to select the proper map (0-15). Map 0 is defined as the executive mode. All other map selections (1-15) are designated as being in the user mode. However, when the system is forced to the executive mode, state 0, by an I/O, real-time, or memory map interrupt, the map register will continue to contain the currently executing user map selection number.

Executive Mode

All instructions except HALT are permitted in this mode. Any interrupt will force the hardware to enter this mode in executive mode state 0. The interrupt will not disable the map. VORTEX Real-Time Executive (RTE), Input/Output Control (IOC), I/O drivers, and other resident tasks and constants are mapped into the executive mode. The instructions and data which comprise the VORTEX nucleus are mapped in the executive mode. Any task executing I/O instructions (EXC, OAR, SEN, etc.) must execute in map 0.

A HALT instruction executed in the executive mode with the map enabled will generate an interrupt. The HALT is permitted only in the disabled map state.

There are four executive modes states as shown in table 1-1. A map 0 task will normally execute in state 0. In state 0, all instruction fetches and operand fetches and stores are performed in map 0 logical memory. If a map 0 task must fetch and store data to or from a user map (1-15), the map 0 task must switch to the proper executive mode state (1, 2 or 3), then upon completion of the fetch or store, restore the executive mode to state 0. A convenient way of switching executive or mode states is to output one of the control words established by the RTE component in the page 0 system data region, locations 0334-0337: V$ST0, V$ST1, V$ST2, and V$ST3 for executive mode states 0 through 3 respectively. An example of switching to executive mode 3 is OME 046, V$ST3, where 046 is the memory-map device address.

User Mode

All operands and instructions are mapped in accordance with the map register contents. Error conditions will cause interrupts, which force the system to the executive mode. User mode is entered from the executive mode under control of RTE.

Privileged instructions (e.g., EXC, HALT) are not permitted in this mode. An interrupt is generated if a task attempts to execute a privileged instruction. Foreground tasks may execute disable and/or enable PIMS and RT clock instructions (EXC 0444, EXC 0244, EXC 0147, EXC 0747). Section 14.4.4 describes this subject further.

Section 2.2, RTE System Flow, describes the user mode and executive mode tasks.

Table 1-1. Executive Mode States

State	Instruction Fetch	Operand Fetch	Store
0	MAP 0	MAP 0	MAP 0
1	MAP 0	MAP 0	*MAP N
2	MAP 0	MAP N	MAP 0
3	MAP 0	MAP N	MAP N

+MAP 0 refers to the executive task map.
*MAP N refers to the task map specified by the map register. (n = 1-15)

1.4 BIBLIOGRAPHY

The following gives the stock numbers of Varian manuals pertinent to the use of VORTEX and the V70/620 computers:

Title	Document Number
V72 Handbook	98 A 9906 20x
V73 Handbook	98 A 9906 01x
V70 Series Memory Map Manual	98 A 9906 10x
620-100 Computer Handbook	98 A 9905 00x
FORTRAN IV Reference Manual	98 A 9902 03x
RPG IV User's Manual	98 A 9947 03x
VTAM Reference Manual	98 A 9952 22x
HASP/RJE Operator's Manual	98 A 9952 21x
Microprogramming Guide	98 A 9952 21x
VORTEX Installation Manual	98 A 9906 07x

Where x is a revision level number subject to change.

Maintenance information is in the following VORTEX and VORTEX II Software Performance Specifications:

Title	Document Number
VORTEX II System Overview	89A0259
VORTEX II External Specification	89A0273
VORTEX II Internal Specification	89A0289
VORTEX External	89A0203
VORTEX Internal Volume 1	89A0231
VORTEX Internal Volume 2	89A0232
VORTEX Internal Volume 3	89A0233
VORTEX Internal Volume 4	89A0304
DAS MR Assembler Internal	89A0225
FORTRAN IV Compiler Internal	89A0214
FORTRAN IV Library Internal	89A0211
RPG IV Runtime/Loader Internal	89A0234
RPG IV Compiler Internal	89A0184
FORTRAN Accelerator and VORTEX Spooler Overview/External	89A0285

SECTION 2
REAL-TIME EXECUTIVE SERVICES

The VORTEX **real-time executive (RTE) component** processes, upon request by a task, operations that the task itself cannot perform, including those involving linkages with other tasks. RTE **service requests** are made by macro calls to V$EXEC, followed by a parameter list that contains the information required to process the request.

The contents of the volatile A and B registers and the setting of the overflow indicator are saved during execution of any RTE macro. After completion of the macro, these values are returned. The contents of the X register are lost. If the task uses the V75 registers 3 through 7, the contents of R3 through R7 are also saved.

There are 32 priority levels in the VORTEX system, numbered 0 through 31. Levels 0 and 1 are for background tasks and levels 2 through 31 are for foreground tasks. If a background task is assigned a foreground priority level, or vice versa, the task automatically receives the lowest valid priority level for the correct environment. Lower numbers assign lower priority. If more than one task has the same priority level, they are selected for execution on a first-in, first-out basis. Background and foreground RTE service requests are similar.

Table 2-1. RTE Service Request Macros

Mnemonic	Description	Level 0	FORTRAN
SCHED	Schedule a task	Yes	Yes
SUSPND	Suspend a task	Yes	Yes
RESUME	Resume a task	No	Yes
DELAY	Delay a task	No	Yes
LDELAY	Delay and reload from specified logical unit	No	Yes
PMSK	Store PIM mask register	No	Yes
TIME	Obtain time of day	Yes	Yes
OVLAY	Load and/or execute an overlay segment	Yes	Yes
ALOC	Allocate a reentrant stack	No	Yes
DEALOC	Deallocate the current reentrant stack	No	No
EXIT	Exit from a task (upon completion)	Yes	Yes
ABORT	Abort a task	No	Yes
IOLINK	Link background I/O	Yes	No
PASS	Pass map 0 data	Yes	Yes
TBEVNT	Set/fetch task's TBEVNT	Yes	No
ALOCPG	Allocate memory page(s) (Priority 0 in map 0)	Yes	No
DEALPG	Deallocate memory page(s) (Priority 0 in map 0)	Yes	No
MAPIN	Map in specified memory page(s)	No	No
PAGNUM	Identify physical page number	Yes	No

Whenever a task is aborted, all currently active I/O requests are completed. Pending I/O requests are dequeued. Only then is the aborted task released.

There are 18 RTE service request macros. Certain of them are illegal in unprotected background (level 0) tasks. Table 2-1 lists the RTE macros, indicates whether they are legal in level 0 tasks, and indicates whether there is a FORTRAN library subroutine (section 13) provided.

Note: A **task name** comprises one to six alphanumeric characters (including $), left-justified and filled out with blanks. Embedded blanks are not permitted.

2.1 REAL-TIME EXECUTIVE MACROS

This section describes the RTE macros given in table 2-1.

The general form of an RTE macro is

```
label        mnemonic,p(1),p(2),...,p(n)
```

where

label permits access to the macro from elsewhere in the program

mnemonic is one of those given in table 2-1

each *p(n)* is a parameter defined under the descriptions of the individual macros

The omission of an optional parameter is indicated by retention of the normal number of commas unless the omission occurs at the end of the parameter string. Thus, in the macro (section 2.1.1)

```
        SCHED        8,,106,,'TA','SK','A'
```

the first double comma indicates a default value for the wait option and the second double comma indicates omission of a protection code.

Error **messages** applicable to RTE macros are given in Appendix A.2.

2.1.1 SCHED (Schedule) Macro

This macro schedules the specified task to execute on its designated priority level. The scheduling task can pass two values in the A and B registers to the scheduled task (a task using the V75 registers 3 through 7 can also pass parameters in R3 through R7). A TIDB is created for each scheduled task, (see section 14 for a description of TIDB). The macro has the general form.

label **SCHED level**,*wait*,**lun**,*key*,**'xx','yy','zz'**

where

level is the value from 0 (lowest) to 31 (highest) of the priority level of the scheduled task

wait is 0 (default value) if the scheduling and scheduled task obtain CPU time based on priority levels and I/O activity, or 1 if the scheduling task is suspended until completion of the scheduled task

lun is the name or number of the logical unit whose library contains the scheduled task, zero to schedule a resident foreground task, or 106 to schedule a nonresident task from the foreground library. If a zero is specified and the task is not found in the resident directory, the RTE component (SAL) will automatically search for the task on the foreground library (FL)

key is the protection code, if any, required to address **lun** (0306 or 'F' to schedule a nonresident task from the foreground library). The foreground library logical unit and its protection key are specified by the user at system-generation time

xxyyzz is the name of the scheduled task in six ASCII characters, coded in pairs between single quotation marks and separated by commas; e.g., the task named BIGJOB is coded 'BI','GJ','OB' and the task named ZAP is coded 'ZA','P',' '

The FORTRAN calling sequence for this macro is

CALL **SCHED(level,***wait***,lib,***key***,name)**

where **lib** is the number of the library logical unit containing the task, and **name** is the three-word Hollerith array containing the name of the scheduled task. The other parameters have the definitions given above.

All tasks are activated at their entry-point locations, with the A and B registers (and the V75 registers if available) containing the value to be passed. The scheduled task executes when it becomes the active task with the highest priority.

The **specified** logical unit (which can be a background library, a foreground library, or any user-defined library on an RMD) must be defined in the schedule-calling sequence.

Expansion: The task name is loaded two characters per word. The wait option flag is bit 12 of word 2 (w).

<table>
<tr><th>Bit</th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Word 0</td><td colspan="16">JSRX</td></tr>
<tr><td>Word 1</td><td colspan="16">0406</td></tr>
<tr><td>Word 2</td><td colspan="3"></td><td>w</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td colspan="6">level</td></tr>
<tr><td>Word 3</td><td colspan="8">key</td><td colspan="8">lun</td></tr>
<tr><td>Word 4</td><td colspan="16">Task name</td></tr>
<tr><td>Word 5</td><td colspan="16">Task name</td></tr>
<tr><td>Word 6</td><td colspan="16">Task name</td></tr>
</table>

Examples: Schedule the foreground library task named TSKONE on priority level 5. Use the no-wait option so that scheduled and scheduling tasks obtain Central-Processor-Unit (CPU) time based on priority levels and I/O activity.

```
FL      EQU     106     (LUN assigned to
                        foreground library FL)
KEY     EQU     0306    (Protection code
                        for FL)
        .
        .
        .
        SCHED   5,0,FL,KEY,'TS','KO','NE'
        .          (Control return to
        .          highest priority)
        .
```

Note: the KEY line can be coded with the equivalent ASCII character enclosed in single quotation marks.

```
KEY       EQU      'F'
```

The same request in FORTRAN is

```
DIMENSION N1,N2(3)
DATA N1/2H F/
DATA N2(1),N2(2),N2(3)/2HTS,2HKO,2HNE/
CALL SCHED(5,0,106,N1,N2)
```

or

```
CALL SCHED(5,0,106,2H F,6HTSKONE)
```

2.1.2 SUSPND (Suspend) Macro

This macro suspends the execution of the task initiating the macro. The task can be resumed only by an external interrupt, a simulated interrupt caused by IOC or I/O completion events for the task, or a RESUME (section 2.1.3) macro. The macro has the general form

lable **SUSPND** **susp**

where **susp** is 0 if the task is to be resumed by RESUME or 1 if the task is to be resumed by external interrupt, or 2 if the task is to be resumed by external interrupt or by IOC or I/O completion events via a simulated interrupt (i.e., TBEVNT word in task's TIDB is set to 1).

The FORTRAN calling sequence for this macro is

CALL SUSPND(susp)

Expansion: The **susp** flag is bit 0 of word 2 (s).

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	J S R,X															
Word 1	0406															
Word 2					0	0	0	0	1	1						s

Example: Suspend a task from execution. Provide for resumption of the task by interrupt, which reactivates the task at the location following SUSPND.

```
SUSPND     1
```

The same request in FORTRAN is

```
CALL SUSPND (1)
```

2.1.3 RESUME Macro

This macro resumes a task suspended by the SUSPND macro. The RESUME macro has the general form

label **RESUME** **'xx','yy','zz'**

where **xxyyzz** is the name of the task being resumed, coded as in the SCHED macro (section 2.1.1).

The RTE searches for the named task and activates it when found. The task will execute when it becomes the task with the highest active priority. If the priority of the specified task is higher than that of the task making the request, the specified task executes before the requesting task and immediately if it has the highest priority.

The FORTRAN calling sequence for this macro is

CALL RESUME(name)

where **name** is the three-word Hollerith array containing the name of the specified task

Expansion: The task name is loaded two characters per word.

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	J S R,X															
Word 1	0406															
Word 2					0	0	0	1	0	0						
Word 3	Task name															
Word 4	Task name															
Word 5	Task name															

Example: Resume (reactivate) the task TSKTWO, which will execute when it becomes the task with the highest active priority.

```
RESUME     'TS','KT','WO'
```

(Control return)

Control returns to the requesting task when it becomes the task with the highest active priority. Control returns to the location following RESUME.

The same request in FORTRAN is

```
DIMENSION N1(3)
DATA N1(1),N1(2),N1(3)/2HTS,2HKT,2HWO/
CALL RESUME(N1)
```

or

```
CALL RESUME(6HTSKTWO)
```

2.1.4 DELAY Macro

This macro suspends the requesting task for the specified time, which is given in two increments. The first increment is the number of 5-millisecond periods, and the second, the number of minutes. The macro has the general form

label **DELAY** **milli**,*min*,*type*

where

milli is the number of 5-millisecond increments delay

min is the number of minutes delay

type is 0 (default value when the task is to be suspended for the specified delay, remain in memory, and automatically resume following the DELAY macro

1 when the task is to exit from tne system, relinquishing memory, and

after the specified delay, be automatically rescheduled and reloaded in a elapsed time mode, or

2 when the task is to resume automatically after the specified delay or upon receipt of an external interrupt whichever comes first, and automatically resume following the DELAY macro; or

3 when the task is to resume automatically after the specified delay, or upon receipt of an external interrupt, or completion of an I/O request initiated previously, whichever comes first, and automatically resume following the DELAY macro.

IOC resumes execution of the task by setting the TBEVNT word in the task's TIDB to 1.

The FORTRAN calling sequence for this macro is

CALL DELAY(milli,min,type)

where the integer-mode parameters have the definitions given above.

The maximum value for either **milli** or *min* is 32767. Any such combination given the correct sum is a valid delay definition; e.g., for a 90-second delay, the values could be 6000 and 1, respectively, or 18000 and 0. After the specified delay, the task becomes active. When it becomes the highest-priority active task, it executes.

Note that the resolution of the clock is a user-specified variable having increments of 5 milliseconds. The time interval given in a DELAY macro must be equal to or greater than the resolution of the clock. The delay interval is stored in minute increments and real-time clock resolution increments.

Expansion: The **type** flag is bits 0 and 1 of word 2.

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	J S R,X															
Word 1	0406															
Word 2	☒				0	0	1	0	0	1	☒				type	
Word 3	milli															
Word 4	min															

Examples: Assuming a 5-millisecond clock increment, delay the execution of a task for 90 seconds. At the end of this time, the task becomes active. When it becomes the highest-priority task, it executes.

```
DELAY     6000,1
```

Delay the execution of a task for 90 seconds or until receipt of an external interrupt, whichever comes first, at which time the task becomes active. Such a technique can test devices that expect interrupts within the delay period.

```
DELAY     18000,0,2
```

Delay the execution of a task for 90 seconds, or until receipt of an external interrupt, or the completion of a previously initiated I/O request, whichever comes first.

```
DELAY     18000,0,3
```

2.1.5 LDELAY Macro

This macro is a type 1 DELAY macro with additional parameters to specify the logical unit from which the task is to be reloaded after the delay. The macro has the general form:

label **LDELAY** **milli,*min*,lun,key**

where

milli is the number of 5-millisecond increments delay

min is the number of minutes delay

lun is the number of the logical unit from which the task is to be loaded after the delay (DELAY tape 1 reloads from FL library)

key is the protection code for the logical unit

The FORTRAN calling sequence for this macro is

CALL LDELAY (milli,min,lun,key)

where the integer-mode parameters have the definitions given above.

Time is the same as specified for DELAY.

Expansion:

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	J S R X															
Word 1	0406															
Word 2	☒				0	0	1	0	0	1	☒			1	1	1
Word 3	milli															
Word 4	min															
Word 5	key								lun							

Example: Assuming a 5-millisecond clock increment, delay the execution of a task for 90 seconds. At the end of this time, the task becomes active. When it becomes the highest priority task, it is loaded from logical unit 128 which has protection key A, and executed.

```
LDELAY          6000,1,128,0301
```

2.1.6 PMSK (PIM Mask) Macro

This macro redefines the PIM (priority interrupt module) interrupt structure, i.e., enables and/or disables PIM interrupts. The macro has the general form

label **PMSK** **pim,mask,***opt*

where

pim is the number (1 through 8) of the PIM being modified

mask indicates the changes to the mask, with the bits indicating the interrupt lines that are either to be enabled or disabled, depending on the value of *opt*, and with the other lines unchanged

opt is 0 (default value) if the set bits in **mask** indicate newly enabled interrupt lines, or 1 if the set bits in **mask** indicate newly disabled interrupt lines

The FORTRAN calling sequence for this macro is

CALL PMSK(pim,mask,opt)

where the integer-mode parameters have the definitions given above.

The eight bits of the mask correspond to the eight priority interrupt lines, with bit 0 corresponding to the highest-priority line.

VORTEX operates with all PIM lines enabled unless altered by a PMSK macro. Normal interrupt-processing allows all interrupts and does one of the following: a) posts (in the TIDB) the interrupt occurrence for later action if it is associated with a lower-priority task, or b) immediately suspends the interrupted task and schedules a new task if the interrupt is associated with a higher-priority task. PMSK provides control over this procedure.

Note: VORTEX (through system generation) initializes all undefined PIM locations to nullify spurious interrupts that may have been inadvertently enabled through the PMSK macro.

Expansion: The *opt* flag is bit 0 of word 2 (o).

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	J S R X															
Word 1	0406															
Word 2					0	0	1	0	0	0						o
Word 3	pim								mask							

Examples: Enable interrupt lines 3, 4, and 5 on PIM 2. Leave all other interrupt lines in the present states.

```
PMSK     2,070
```

The same request in FORTRAN is

```
CALL PMSK(2,56,0)
```

Disable the same lines.

```
PMSK     2,070,1
```

2.1.7 TIME Macro

This macro loads the current time of day in the A and B registers with the B register containing the minute, and the A register the 5-millisecond, increments. The macro has the form

label **TIME**

The FORTRAN calling sequence for this macro is

CALL TIME(min,milli)

where **min** is the integer minutes to the 24 hour total, and **milli** is the seconds in 5-millisecond integer increments.

Expansion:

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	J S R X															
Word 1	0406															
Word 2					0	0	1	0	1	0						

Example: Load the current time of day in the A (5 millisecond increments) and B (1-minute increments) registers.

```
TIME
(Return with time in A
and B registers)
```

2.1.8 OVLAY (Overlay) Macro

This macro loads and/or executes overlays within an overlay-structured task. It has the general form

label **OVLAY** *type,'xx','yy','zz'*

where

type is 0 (default value) for load and execute, or 1 for load and return following the request. If only load is specified, the load address is returned in the X register.

xxyyzz is the name of the overlay segment, coded as in the SCHED macro (section 2.1.1)

The FORTRAN calling sequence for this macro is

```
        CALL        OVLAY(type,reload,name)
```

where **type** is a constant or name whose value has the definition given above, **reload** is a constant or name with the value **zero** to load or non-zero to load only if not currently loaded, and **name** is a three-word Hollerith array containing the overlay segment name.

FORTRAN overlays must be subroutines if called by a FORTRAN call.

Expansion: The overlay segment name is loaded two characters per word. The type flag is bit 0 of word 2 (t).

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	JSR X															
Word 1	0406															
Word 2					0	0	1	0	1	1						t
Word 3	Overlay segment name															
Word 4	Overlay segment name															
Word 5	Overlay segment name															

When the load and execute mode is selected in the OVLAY macro RTE executes an equivalent of a root segment JSR instruction to enter the overlay segment. Therefore, the return address of the root segment is available to the overlay segment in the X register.

Example: Find, load, and execute overlay segment OVSG01 without return.

```
            OVLAY       0,'OV','SG','01'
                          (No return)
```

The same request in FORTRAN is

```
DIMENSION N1(3)
DATA N1(1),N1(2),N1(3)/2HOV,2HSG,2H01/
CALL OVLAY(0,0,N1)
```

or

```
CALL OVLAY(0,0,6HOVSG01)
```

External subprograms may be referenced by overlays. If a subprogram S is called in several overlays, and S is not in the main segment, each overlay will be built with a separate copy of S.

When using FORTRAN overlays containing I/O statements for RMD files defined by CALL V$OPEN or CALL V$OPNB statements (described in section 5.3.2), the main segment must contain an I/O statement so that the runtime I/O program (V$FORTIO) will be loaded with the main segment. FCB arrays must be in the main segment or in common, so they are linked in memory and cannot be in any overlay.

2.1.9 ALOC (Allocate) Macro

This macro allocates space in a push-down (LIFO) stack of variable length for reentrant subroutines. The macro has the general form

```
        label       ALOC        address
```

where **address** is the address of the reentrant subroutine to be executed.

The FORTRAN calling sequence for this macro is

```
        EXTERNAL  subr
        CALL        ALOC(subr)
```

where **subr** is the name of the DAS MR assembly language subroutine.

The first location of the LIFO stack is V$FLRS, and that of the current position in the stack is V$CRS. The first word of the reentrant subroutine, whose address is specified in the general form of ALOC, contains the number of words to be allocated. If fewer than five words are specified, five words are allocated.

Control returns to the location following ALOC when a DEALOC macro (section 2.1.10) is executed in the called subroutine. Between ALOC and DEALOC, (1) subroutine cannot be suspended, (2) no IOC calls (section 3) can be made, and (3) no RTE service calls can be made.

Reentrant subroutines are normally included in the resident library at system-generation time so they can be concurrently accessed by more than one task. The maximum size of the push-down stack is also defined at system-generation time

Expansion:

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	JSR X															
Word 1	0406															
Word 2					0	0	0	1	1	0						
Word 3	Reentrant subroutine address															

Reentrant subroutine: The reentrant subroutine called by ALOC contains, in entry location x, the number of words to be allocated. Execution begins at x + 1. The reentrant subroutine returns control to the calling task by use of a DEALOC macro.

The reentrant stack is used to store register contents and allocate temporary storage needed by the subroutine being called. The location V$CRS contains a pointer to word 0 of the current allocation in the stack. By loading the value of the pointer into the X (or B) register, temporary storage cells can be referenced by an assembly language M field of 5,1 for the first cell; 6,1 for the second; etc.

A stack allocation generated by the ALOC macro has the format:

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	Contents of the A register															
Word 1	Contents of the B register															
Word 2	Con:ents of the X register															
Word 3	ovfl	Contents of the P register														
Word 4	Stack-control pointer (for RTE use only)															
Word 5 . . . Word n	For reentrant subroutine use (temporary storage)															
Words n + 1 to n + 5	V75 registers 3 7															

where ovfl is the overflow indicator bit.

The current contents of the A and B registers are stored in words 0 and 1 of the stack and are restored upon execution of the DEALOC macro. The same procedure is used with the setting of the overflow indicator bit in word 3 of the stack. The contents of word 2 (X register) point to the location of the reentrant subroutine to be executed following the setting up of the stack. The contents of word 3 (bits 14-0) point to the return location following ALOC.

Example: Allocate a stack of six words. Provide for deallocation and returning of control to the location following ALOC.

```
        EXT     SUB1
        ALOC    SUB1
                (Return Control)
        .
        .
        NAME    SUB1
SUB1    DATA    6
        .
        .
        .
        DEALOC
        END
```

Each time SUB1 is called, six words are reserved in the reentrant stack. Each time the reentrant subroutine makes a DEALOC request (section 2.1.10), six words are deallocated from the reentrant stack. If the calling task uses the V75 registers, 11 words are allocated/deallocated.

2.1.10 DEALOC (Deallocate) Macro

This macro deallocates the current reentrant stack, restores the contents of the A and B (and V75) registers and the setting of the overflow indicator to the requesting task, and returns control to the location specified in word 3 (P register value) of the reentrant stack (section 2.1.9). The macro has the form

label **DEALOC**

Expansion:

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	J S R,X															
Word 1	0406															
Word 2					0	0	0	1	1	1						

Example: Release the current reentrant stack, restore the contents of the volatile registers and the setting of the overflow indicator and return control to the location specified in word 3 of the stack.

```
        .
        .
        .           (Reentrant subroutine)
        DEALOC
        END
```

2.1.11 EXIT Macro

This macro is used by a task to signal completion of that task. The requesting task is terminated upon completion of its I/O. The macro has the form

label **EXIT**

The FORTRAN calling sequence (no parameters specified) is

CALL EXIT

If the task making the EXIT is in unprotected background memory, the macro schedules the job-control processor (JCP) task (section 4).

Expansion:

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	J S R,X															
Word 1	0406															
Word 2					0	0	0	0	1	0						

Example: Exit from a task. The task making the EXIT call is terminated upon completion of its I/O requests.

```
        .
        .
        .
        EXIT            (No return)
```

2.1.12 ABORT Macro

This macro aborts a task. Active I/O requests are completed, but pending I/O requests are dequeued. The macro has the general form

```
        label        ABORT      'xx','yy','zz'
```

where **xxyyzz** is the name of the task being aborted, coded as in the SCHED macro (section 2.1.1).

The FORTRAN calling sequence for this macro is

```
        CALL ABORT(name)
```

where **name** is the three-word Hollerith array containing the name of the task being aborted.

Expansion: The task name is loaded two characters per word.

Bit	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Word 0	J S R,X
Word 1	0406
Word 2	☒ 0 0 0 1 0 1 ☒
Word 3	Task name
Word 4	Task name
Word 5	Task name

Example: Abort the task TSK and return control to the location following ABORT.

```
            •
            •
            •
            ABORT     'TS','K','  '
            •      (Control return)
            •
            •
```

The same request in FORTRAN is

```
DIMENSION N1(3)
DATA N1(1),N1(2),N1(3)/2HTS,2HK ,2H  /
CALL ABORT(N1)
```

or

```
CALL ABORT(6HTSK    )
```

2.1.13 IOLINK (I/O Linkage) Macro

This macro enables background tasks to pass buffer address and buffer size parameters to the system background global FCBs. It has the general form

```
        label        IOLINK       lungsd,bufloc,bufsiz
```

where

lungsd is the logical unit number of the global system device

bufloc is the address of the input/output buffer

bufsiz is the size of the buffer (maximum and default value: 120

```
            ABORT     'TS','  ','  '
```

Global file control blocks: There are eight global FCBS (section 3.5.11) in the VORTEX system reserved for background use. System background and user programs can reference these global FCBs. JCP directive /PFILE (section 4.2.11) stores the protection code and file name in the corresponding FCB before opening/rewinding the logical unit. The IOLINK service request passes the buffer address and the size of the record to the corresponding logical-unit FCB. The names of the global FCBs are *SIFCB, PIFCB, POFCB, SSFCB, BIFCB, BOFCB, GOFCB,* and *LOFCB*, where the first two letters of the name indicate the logical unit.

Bit	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Word 0	J S R,X
Word 1	0406
Word 2	☒ 0 0 1 1 0 0 lungsd
Word 3	bufloc
Word 4	bufsiz

Example: Pass the address and size specifications of a 40-word buffer at address BUF to the PI global FCB.

```
PI        EQU       4
          EXT       PIFCB
          •      (PI logical-unit number 4)
          •
          •
          IOLINK    PI,BUF,40
          READ      PIFCB,P1,0,1
          •      (Read 40 ASCII words
                    from PI)
          •
          •
BUF       BSS       40
          END
```

If the PI file is on an RMD, reassign the PI to the proper RMD partition, and then position the PI file using JCP directive /PFILE.

2.1.14 PASS Macro

This macro fetches map 0 data into the user map. It has the general form

```
        label        PASS        count,from,to
```

where

count	is the number of words to be passed
from	is the map 0 fetch address
to	is the user map store address

The FORTRAN calling sequence for this macro is:

```
        CALL PASS(count,from,to)
```

Expansion:

Bit	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Word 0	J S R,X
Word 1	0406
Word 2	0 0 1 1 1 0
Word 3	count
Word 4	from
Word 5	to

If a negative or zero word count is specified, an EX16 error message is posted and the task aborted. Any memory protection violation will result in an EX20-EX25 error message.

Example: Pass the TIDB information into PBUF

```
V$CTL  EQU   0300

       LDA   V$CTL      (Get TIDB address)
       STA   P1+4
P1     PASS  29,*,PBUF
       .
       .
       .
PBUF   BSS   29
       END
```

2.1.15 TBEVNT (Set or Fetch TBEVNT) Macro

This macro fetches or sets the requesting task's event word, TBEVNT, as well as alters other TIDB entries. It should be noted here that most changes to TIDB entries could cause irrecoverable errors, so TBEVNT should be used with caution.

The macro has the general form:

```
        label        TBEVNT        value, disp, c/s
```

where:

value	is 0-0177777 (mask)
disp	is the TIDB word ordinal number (displacement) to be altered
c/s	is the clear/set indication

Explanation:

If *disp* = 0, the following is done according to the value parameter. If value is 0-0177776 it is set into the requesting task's TIDB event word, TBEVNT. If the value is 0-017777, the request will fetch TBEVNT from the requester's TIDB and return with the A register set to the TBEVNT content. (See section 14 for information on use of the event word.)

If *disp* ≠ 0, the action depends on the c/s indication. When c/s = 1 (i.e., set), the corresponding TIDB (word number displacement) bits are set according to the ones in the mask value. OR

When *c/s = 0 (i.e., reset), the corresponding TIDB (word number displacement)* are reset according to the zero bits in the mask value.

Bit	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Word 0	J S R,X
Word 1	0406
Word 2	0 0 1 1 1 1
Word 3	Value
Word 4	disp
Word 5	c/s

Default values: *disp* = 0 c/s = 0

Example: Reset TBPL (word 2 of TIDB) bit 8 and then set it again.

```
        TBEVNT 0177377, 2, 0   AND   (reset)
        TBEVNT 0400, 2, 1      OR    (set)
```

2.1.16 ALOCPG (Allocate Memory Pages) Macro

This macro allocates in physical pages from the pool of available pages to logical pages starting at the specified logical address, modulo 01000. The logical pages to be mapped must not have been previously assigned. The logical pages are assigned as read/write access mode. If an

CALL DEAL'S

error condition occurs, an EX27 error message is output and the task resumes operation at the specified reject address. The general form is

```
        label         ALOCPG  n,logical addr,reject addr
```

where

n — is the number of pages to be allocated

logical addr — is the logical address, modulo 01000, where the n pages are allocated. If the logical address is negative (1's complement) the address is assumed to be in map 0. If the logical address is positive, the address is assumed to be the requestor's map (priority tasks cannot allocate memory in map 0)

reject addr — is the error return address when a task exits or is aborted all ALOEPG pages are automatically deallocated.

Expansion:

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	J S R,X															
Word 1	0406															
Word 2	☒				0	1	0	0	0	0	☒					
Word 3	n															
Word 4	logical addr															
Word 5	reject addr															

Example: Allocate 4 pages of memory to the requesting task's virtual memory starting at logical address 06000. If error, go to ERR01.

```
           ALOCPG     4,06000,ERR01
           .
           .
           .
ERR01      STA        (Error routine)
```

2.1.17 DEALPG (Deallocate Memory Pages) Macro

This macro deallocates n pages of memory starting at the specified logical address, modulo 01000. The deallocated logical pages are set to unassigned access mode. Deallocated physical pages, which were not assigned by MAPIN requests, are returned to the pool of available pages. Specifying logical page 0 or non-read/write page results in EX30 error message to be posted and the task's operation resumed at the reject address. The general form is

```
        label         DEALPG  n,logical addr,reject addr
```

where

n — is the number of pages to be deallocated

logical addr — is the logical address, modulo 01000, where the n pages are deallocated if negative, 1's complement of map 0 logical address (illegal for priority 0 tasks)

reject addr — is the error return address

Expansion:

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	J S R,X															
Word 1	0406															
Word 2	☒				0	1	0	0	0	1	☒					
Word 3	n															
Word 4	logical addr															
Word 5	reject addr															

Example: Deallocate 4 pages of memory in the requesting task's virtual memory starting at logical address 06000. If error, go to ERR02.

```
           .
           DEALPG     4,06000,ERR02
           .
           .
ERR02      LDA             (Error routine)
           .
           .
```

2.1.18 MAPIN (Map-In Specified Physical Pages of Memory) Macro

This macro allows the requestor to specify physical pages of memory to be assigned to the requestor's logical memory starting at the specified logical address, modulo 01000. Priority 0 tasks are not permitted to execute the MAPIN request. The specified logical pages to be mapped must not have been previously assigned except by a previous MAPIN request. All logical pages are set to the read/write access mode. Pages mapped in by this request do not effect the pool of available pages. The requested physical pages cannot include page 0 nor any of the pages assigned to the nucleus program module. Any error condition causes EX31 to be output and the task resumed at the reject address. The general form is

```
label        MAPIN       n,logical addr,
                              buffer or page,
                              reject addr
```

where

n is the number of pages of memory to be allocated

logical addr is the requestor's logical address, modulo 01000, where the specified physical pages are to be mapped

buffer address or physical page number is the actual physical page number to be mapped or the address of the buffer containing the physical page numbers. If the value is positive and less than 512, it is assumed to be a physical page number. If n is greater than 1, all physical pages assigned will be consecutive. If the value is positive and greater than 511, it is assumed to be a map 0 buffer address, e.g., TIDB map image address. If the value is negative, it is assumed to be the one's complement of the buffer address within the requestor's logical space, which contains the physical page numbers

reject addr is the error return address

Expansion:

Bit	15 14 13 12 11 10 9 7 6 5 4 3 2 1 0
Word 0	J S R,X
Word 1	0406
Word 2	☒ 0 1 0 0 1 0 ☒
Word 3	n
Word 4	logical addr
Word 5	buffer addr of physical page
Word 6	reject addr

Example: Copy the same 2 physical pages as used by task A, logical address ABUF, into task B's logical memory at logical address BBUF. Task A scheduled task B, passing task A's TIDB address to task B.

```
TASK A
            NAME        TASKA
            TITLE       TASKA
FL          EQU         106
KEY         EQU         0306
V$CTL       EQU         0306
            .
            LDBI        ABUF            (B = Buffer Address)
            LDA         V$CTL           (A = Task A's TIDB)
            SCHED       2,0,FL,KEY,      'TA','SK','B'
            .                          (Schedule task B, pass
            .                          parameters in A, B)
            .
ABUF        BSS         02000
            END

TASK B

            NAME        TASKB
            TITLE       TASKB
TBMING      EQU         27
TASKB       STA         P1+4            (Set task A's TIDB addr)
P1          PASS        29,*,PBUF       (Pass task A's TIDB
                                        into PBUF)

*           .
            TBA                         (B = ABUF addr)
            TZB
            LLSR        9               (A = Page number B =
                                        offset in page)
            ADDE        TBMING+PBUF
            STA         M1+5            (Add task A's map image
                                        addr
M1          MAPIN       2,BBUF,*        (MAPIN same 2 physical
                                        pages at BBUF shared by
            TBA                         task A at ABUF)
            LSRA        7               (B = Offset into page)
            ADDI        BBUF            (Add BBUF addr)
            TAB                         (B = Start of ABUF)
            .
            .
PBUF        BSS         29              (TIDB buffer)
            BSS         TASKB-*+512     (Set to page boundary)
BBUF        EQU         *               (Assume task B < 512
                                         words )
            END
```

2.1.19 PAGNUM (Identify Physical Page Number) Macro

This macro allows the requestor to identify the physical page number assigned to a specified logical address. If an unassigned logical address is specified, return is to the requestor with the A register = 0. Otherwise, return is made with the A register set to the physical page number and the B register set to the task's map image address for the specified logical address. The general form is

```
label        PAGNUM       logical addr
```

where **logical addr** is the address where the identity of the assigned physical page is requested.

Expansion:

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	J S R,X															
Word 1	0406															
Word 2	☒				0	1	0	0	1	1	☒					
Word 3	logical addr															

Example: Identify the physical page assigned to PBUF.

```
        *
        LDAI     PBUF      (Get RBUF addr)
        STA      P1+3
P1      PAGNUM   *         (Identify physical page)
        *
        *
        *
PBUF    BSS      100
```

2.2 RTE SYSTEM FLOW

The RTE component loads and executes a task depending on the category of that task:

Executive Mode Tasks

These are the VORTEX system and user tasks designated during system generation (SGEN) to be resident (excludes tasks specified on SGEN TSK directives). The RTE, IOC, I/O drivers, and common interrupt processors are examples of system executive mode tasks (map 0). OPCOM is loaded into and executed from page 1 of map 0. All other non-resident tasks are defined to be user mode tasks.

User Mode Tasks

a. Background tasks with a priority of zero: Tasks that are executed via a DASMR or FORTRAN load-and-go operation and those that are loaded and executed from the BL library with a JCP/LOAD directive are in this group.
These tasks are loaded with the first page of physical memory (0-0777) designated as read operand only. The literal and indirect pointer pool is loaded in the first page at locations 0500-0777. The remainder of the background task is loaded in whatever physical pages are available at the time the task is loaded. These pages are designated as read/write access. If a nucleus module is referenced, that module is mapped as read operand only. All other pages in the logical memory are designated as unassigned. The RTE component designates an available map key (1-15) to the background task and sets the appropriate mapping registers to reflect the task's logical memory.

b. Background priority 1 tasks: System tasks such as the Job-Control Processor (JCP), Input/Output Utility (IOUTIL), System Maintenance (SMAIN), Source Editor (SEDIT), DAS MR, FORTRAN, RPG IV, MIDAS, MICSIM, and File Maintenance (FMAIN) require full access to the nucleus (to modify tables or utilize the global FCBs). These tasks are loaded with the required nucleus modules designated as read/write access mode permitting fetches and stores into these areas. The literal and indirect pointer pool is loaded in the first page at locations 0500-0777. The task is loaded starting at logical address 01000.

c. Foreground tasks: Page 0 is mapped read operand only for a foreground task. Nucleus modules (including blank common) referenced by foreground tasks, are mapped in the read/write access mode (see figure 2-1). The maximum logical memory space available to a foreground task is thus dependent on the number and type of nucleus module referenced by the task. The pages within the logical memory not utilized are mapped as unassigned. All foreground tasks are loaded at logical memory address 01000.

d. Read-only pages: During the creation of a load module by LMGEN, the user has the capability to specify pages within the load module as read-only pages. The designated read-only pages are indicated in the pseudo TIDB block. When the task is loaded, the RTE component will designate those pages in the task's logical memory as read-only pages.

2.3 TASK LIMITATIONS AND DIFFERENCES

In VORTEX the following differences and features are apparent between a background task and a foreground task:

a. A background task has a priority level of 0 or 1. A foreground task can have a priority of 2 through 31.

b. Only one background task can be executed at a time. Excluding the RTE, IOC, and I/O driver tasks, a maximum of 15 (user mode of 1 through 15) user foreground tasks can be in operation concurrently, provided physical memory size is adequate. See section 2.5 for a description of checkpointing of tasks.

c. A background task can be checkpointed and its operation pre-empted by a foreground task. A foreground program memory space is not checkpointed (see section 2.5).

d. A background task can have literals and indirect pointers, a foreground task cannot

e. All tasks whether background or foreground have individual task protection.

f. If allocable memory is not available to load a background task, the RTE component will output an error message (EX05) and abort the operation. If a foreground task is to be loaded and allocatable memory is not available, the RTE component will reattempt the load when memory becomes available.

g. Background level 0 or 1 task can schedule a task from the background library only. Foreground tasks cannot schedule a task from the background library.

h. Foreground tasks can utilize foreground blank common. Background tasks cannot.

i. Background level 0 tasks have restricted RTE requests (see table 2-1). Foreground tasks have no restriction on RTE service requests.

		Priority of Task	
	Background Priority	**Background Priority**	**Foreground Priorities**
Nucleus Modules	0	1	2-31
Foreground Blank COMMON Nucleus Module	UN	UN	RW
Global FCT Nucleus Module	ROP	RW	UN
System Table Nucleus Module	ROP	RW	RW
System Resident Tasks Nucleus Module	UN	UN	UN
Page 0 System Constants	ROP	RW	ROP

Key:

RW	Read-Write Access Mode
ROP	Read Operand Only Access Mode
RO	Read-Only Access Mode
UN	Unassigned Access Mode

Note: Since the upper three modules are defined contiguously, without regard to page boundaries, and since maps are full pages, a map for any of these modules may include a partial page of an adjoining module, with the same access mode.

Figure 2-1. Matrix of Nucleus Module Access Mode

2.4 ABORT PROCEDURE

Whenever a task is aborted, all currently active I/O operations are allowed to complete. All I/O requests that are threaded (queued, or waiting to be activated) are not activated. Upon completion of all active I/O operations and after all pending requests are dethreaded, the aborted task is released.

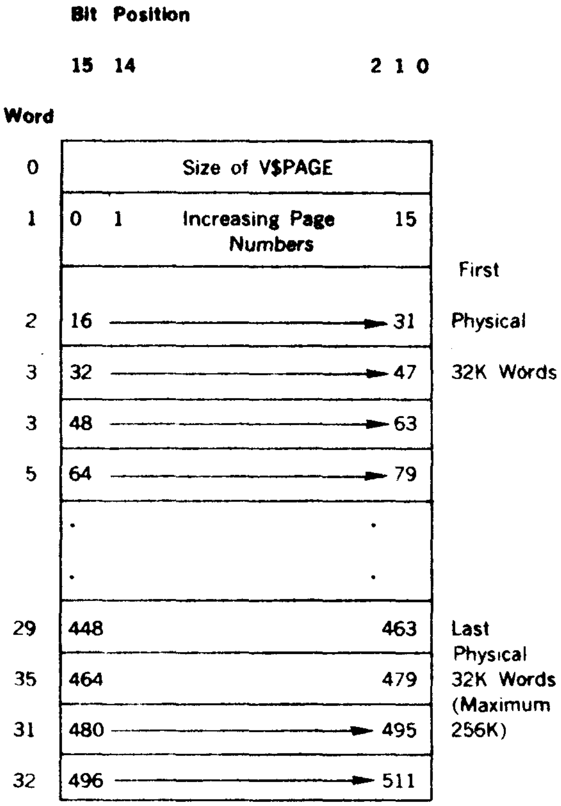
2.5 CHECKPOINTING OF TASKS

A background task's memory space and/or assigned map may be checkpointed for use by a foreground task. The background task is restarted when memory space and/or a map key becomes available.

A foreground task may be checkpointed by a higher priority foreground task. It may also be checkpointed by a lower priority task depending on the value of TBST bit 8. The default value of this bit is on (=1) i.e., "may be checkpointed by a lower priority task". In order to turn this bit off, a usage of TBEVNT (2.1.15) is recommended. The foreground task's memory space is never checkpointed. More than one foreground task's map may be checkpointed.

2.6 PAGE ALLOCATION SCHEME

The page allocation routine scans the page bit mask table, V$PAGE (figure 2-2) to determine the allocable physical pages. To expedite the process, the allocation routine first checks the page 0 system word V$NPAG to find the total number of allocable pages in V$PAGE. If the required number of pages exceeds V$NPAG, scanning of V$PAGE is not attempted. The allocation routine scans V$PAGE starting with the word number specified in V$LPP (page 0 system pointer). The system generation program initially sets V$LPP to 0. The allocation routine updates V$LPP during the scanning while the page deallocation routine sets V$LPP to the deallocated pages.



Corresponding Page Bit Positions:

1 = Page is allocatable

0 = Page is unallocatable

V$PGT	Address of V$PAGE
V$LPP	0, Pointer to last word tested
V$NPAG	Number of available pages

Figure 2-2. V$PAGE, Page Allocation Table

The size of V$PAGE is determined by SGEN based on the physical memory size specified on the MRY directive.

SECTION 3
INPUT/OUTPUT CONTROL

The VORTEX **input/output-control component** (IOC) processes all requests for I/O to be performed on peripheral devices. The IOC comprises an I/O-request processor, a find-next-request processor, an I/O-error processor, and I/O drivers. The IOC thus provides a common I/O system for the overall VORTEX operating system and eliminates the programmer's need to understand the computer hardware.

All I/O with remote devices conneçted through the Data Communications Multiplexor (DCM) uses the VORTEX Telecommunications Access Method (VTAM). VTAM interfaces with IOC. Use of VTAM is described in the VTAM Reference Manual.

The contents of the volatile A and B registers and the setting of the overflow indicator are saved during execution of any IOC macro. After completion of the macro, these data are returned. The contents of the X register are lost.

If a physical-device failure occurs, the I/O drivers perform error recovery as applicable. Where automatic error recovery is possible, the recovery operation is attempted repeatedly until the permissible number of recovery tries has been reached, at which time the I/O driver stores the error status in the user I/O-request block, and the I/O-error processor posts the error on the OC logical unit. The user can then try an_.her physical device or abort the task.

3.1 LOGICAL UNITS

A **logical unit** is an I/O device or a partition of a rotating-memory device (RMD). It is referenced by an assigned number or name. The logical unit permits performance of I/O operations that are independent of the physical-device configurations by making possible references to the logical-unit number. The standard interfaces between the program and the IOC, and between the IOC and the I/O driver, permit substitution of peripheral devices in I/O operations without reassembling the program.

VORTEX permits up to 256 logical units. The numbers assigned to the units are determined by their reassignability:

a. *Logical-unit numbers 1-100* are used for units that can be reassigned through the operator communications component (OPCOM, section 17) or the job-control processor (JCP, section 4).

b. *Logical-unit numbers 101-179* are used for units that are not reassignable.

c. *Logical-unit numbers 180-255* are used for units that can be reassigned through OPCOM only.

d. *Logical-unit number 0* indicates a dummy device. The IOC immediately returns control from a dummy device to the user as if a real I/O operation had been completed.

VORTEX logical-unit assignments for all systems are specified in table 3-1. All logical-unit numbers that are not listed are available to the reassignability scheme above.

Table 17-1 shows the scheme of system names for physical devices. Table 3-2 shows the possible logical-unit assignments.

Table 3-1. VORTEX Logical-Unit Assignments

Number	Name	Description	Function
0	DUM	Dummy	For I/O simulation
1	OC	Operator communication	For system operator communication with immediate return to user control; Teletype or CRT only
2	SI	System input	For inputs of all JCP control directives to any device
3	SO	System output	For display of all input control directives and output system messages; Teletype or CRT only
4	PI	Processor input	For input of source statements from all operating system language processors

(continued)

Table 3-1. VORTEX Logical-Unit Assignments

(continued)

Number	Name	Description	Function
5	LO	List output	For output of operating system input control directives, system operations messages, and operating system language processors' output listings
6	BI	Binary input	For input of object-module records from operating system processors
7	BO	Binary output	For output of object-module records from operating system language processors
8	SS	System scratch	For system scratch use; all operating system language processors that use an intermediate scratch unit input from this unit
9	GO	Go unit	For output of the same information as the BO unit by the system assembler and compiler; RMD partition or MT.
10	PO	Processor output	For processor output; all operating system language processors that use an intermediate scratch unit output to this unit; PO and SS are assigned to the same device at system-generation time
11	DI	Debugging input	For all debugging inputs
12	DO	Debugging output	For all debugging outputs
101	CU	Checkpoint unit	For use by VORTEX to checkpoint a background task; partition protection key S; RMD partition only
102	SW	System work	For generation of a load module by the system load-module generator component, or for cataloging, loading, or execution by other system components; partition protection key B; RMD partition only
103	CL	"Core" -resident library	For all "core" -resident system entry points; partition protection key C; RMD partition only (12 names per 2 sectors)

Table 3-1. VORTEX Logical-Unit Assignments
(continued)

Number	Name	Description	Function
104	OM	Object-module library	For the VORTEX system object-module library; partition protection key D; RMD partition only
105	BL	Background library*	For the VORTEX system background library; partition protection key E; RMD partition only
106	FL	Foreground library*	For the VORTEX system foreground library; partition protection key F; RMD partition only

* Other units can be assigned as user foreground libraries provided they are specified at system-generation time. However, there is only one background library in any case.

Table 3-2. Valid Logical-Unit Assignments

Logical Unit	**OC**	**SI**	**SO**	**PI**	**LO**	**BI**	**BO**	**SS**	**GO**
Unit No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Device									
Dummy				DUM	DUM	DUM	DUM	DUM	
Card punch					CP		CP		
Card reader		CR		CR		CR			
CRT device	CT	CT	CT	CT	CT				
RMD (disc/drum) partition		D		D	D	D	D	D	D
Line printer					LP				
Magnetic-tape unit		MT		MT	MT	MT	MT	MT	MT
Paper-tape reader/ punch		PT		PT	PT	PT	PT		
Teletype	TY	TY	TY	TY	TY				
Remote Teletype		TC	TC	TC	TC				

Logical Unit	**PO**	**DI**	**DO**	**CU**	**SW**	**CL**	**OM**	**BL**	**FL**
Unit No.	**10**	**11**	**12**	**101**	**102**	**103**	**104**	**105**	**106**
Device									
Dummy	DUM		DUM						
Card punch	CP								
Card reader		CR							
CRT device	CT	CT	CT						
RMD (disc/drum) partition	D			D	D	D	D	D	D
Line printer	LP		LP						
Magnetic-tape unit	MT								
Paper-tape reader/ punch	PT								
Teletype	TY	TY	TY						
Remote Teletype		TC	TC						

3.2 RMD FILE STRUCTURE

Each RMD (rotating-memory device) is divided into up to 20 memory areas called **partitions**. Each partition is referenced by a specific logical-unit number. The boundaries of each partition are recorded in the core-resident **partition specification table (PST)**. The first word of the PST contains the number of VORTEX physical records per track. The second word of the PST contains the address of the bad-track table, if any, or zero. Subsequent words in the PST comprise the partition entries. Each PST entry is in the format:

Bit	**15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0**		
Word 0	**Beginning partition address (track number)**		
Word 1	ppb		Protection key
Word 2	Number of bad tracks in the partition		
Word 3	Ending partition address + 1		

Section 9.1 describes the full PST format.

The **partition protection bit**, designated ppb in the above PST entry map, when set, requires the correct protection key to read/write from this partition.

Note that PST entries overlap. Thus, word 3 of each PST entry is also word 0 of the following entry. The length of the PST is 3n + 2, where n is the number of partitions in the system. The relative position of each PST entry is recorded in the **device specification table (DST)** for that partition.

The **bad-track table**, whose address is in the second word of the PST, is a bit string constructed at system-generation time and thereafter constant. The bits are read from right to left within each word, and forward through contiguous words, with set bits flagging bad tracks on the RMD.

Each RMD partition can contain a **file-name directory** of the files contained in that partition. The beginning of the directory is in the first sector of that partition. The directory for each partition has a variable number of entries arranged in n sectors, 19 entries per sector. Sectors containing directory information are chained by pointers in the last word of each sector. Thus, directory sectors need not be contiguous. (**Note:** Directories are not automatically created when the partitions are defined at system-generation time. It is possible to use a partition with no directory, e.g., by a foreground program that is collecting data in real time.) Each directory entry is in the format.

Bit	**15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0**
Word 0	File name
Word 1	File name
Word 2	File name
Word 3	Current position of file
Word 4	Beginning file address
Word 5	Ending file address

The file name comprises six ASCII characters packed two characters per word. Word 3 contains the current address at which the file is positioned, is initially set to the ending file address, and is manipulated by the OPEN and CLOSE macros (sections 3.5.1 and 3.5.2). The extent of the file is defined by the addresses set in words 4 and 5 when the file is created, and which remain constant.

At system-generation time, the first sector of each partition is assigned to the file-name directory and a zero written into the first word. Once entries are made in the file-name directory, the first word of each sector contains a count of the entries in that sector.

The last entry in each sector is a one-word entry containing either the value 01 (end of directory), or the address of the next sector of the file-name directory.

The file-name directories are created and maintained by the VORTEX file-maintenance component (section 9) for IOC use. User access to the directories is via the IOC, which references the directories in response to the I/O macros OPEN and CLOSE. The file-maintenance component sets words 0, 1, 2, 4, and 5 of each directory entry, which then remain constant and unaffected by IOC operations. The IOC can modify only the current position-of-file parameter.

In the case of a file containing a directory, an OPEN is required before the file is accessible. The macro searches the file directory for the entry corresponding to the name in the file-control block (FCB) in use. When the entry is found, the file boundary addresses and the current position-of-file value from the directory entry are stored in the FCB. If the OPEN macro

a. Specifies the option to rewind, the FCB current position is set equal to the address of the beginning of file.

b. Specifies the option not to rewind, the FCB current position is set equal to the address of the position of file.

Once a file is thus opened, READ and WRITE operations are enabled. The IOC references the file by the file boundary values set by the OPEN, rather than by the file name. READ and WRITE operations are under control of the FCB current position value, the extent of the file, and the current record number.

A CLOSE macro disables the IOC and user access to the file by zeroing the four file-position parameters in the FCB. If the CLOSE macro

a. Specifies the option to update, the current position-of-file value in the directory entry is set to the value of the FCB current position, allowing reference by a later OPEN.

b. Specifies the option not to update, the file-directory entry remains unmodified.

Special directory entries: A **blank entry** is created when a file name is deleted, in which case the file name is ****** and words 3 through 5 give the extent of the blank file. A **zero entry** is created when one name of a multiname file is deleted, in which case the deleted name is converted to a *blank entry* and all other names of the multiname file are set to zero.

3.3 I/O INTERRUPTS

VORTEX uses a complete, interrupt-driven I/O system, thus optimizing the allocation of CPU cycles in the multiprogramming environment.

3.4 SIMULTANEOUS PERIPHERAL OUTPUT OVERLAP (SPOOL)

The VORTEX spooler is a generalized set of routines which permit queuing of a task's output to intermediate RMD files. This avoids the user task waiting for the device transfer completion. Total system throughput will be increased because waiting for transfers to be completed, both in the use of I/O calls with suspended returns and that of tasks which are terminating, will be minimized.

Also, non-resident tasks may transfer to a spooled device and immediately exit, instead of remaining resident until completion of the transfer.

At system generation, the user may have the output of some logical units, such as LO, automatically spooled. During operation, the operator may assign device outputs to the spooler through JCP or OPCOM assign directives.

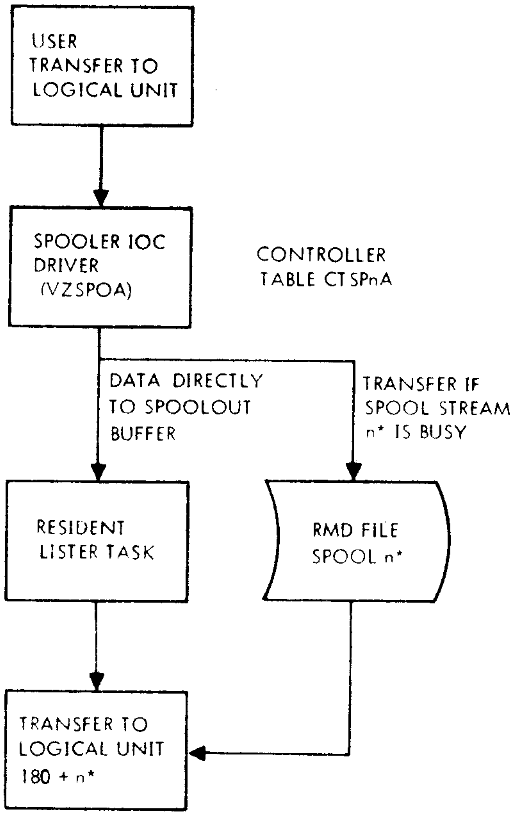
Components

The SPOOL subsystem consists of two components: (1) an IOC driver to which data output may be assigned and which transfers output for its associated logical unit to a circular RMD file or directly to the output listing task, and (2) and output listing task which accepts messages from this circular RMD file or directly from the IOC driver and transfers them to the appropriate output device.

Communication between these two tasks is accomplished through parameters within the listing rask which are established by the IOC driver. When these and other system parameters indicate that the listing task has caught up with the spoolout task, output messages will be transferred directly to the listing task, instead of going through the RMD SPOOL file. (This avoids the overhead of two RMD transfers).

All data records transferred to the circular RMD file will contain record length and a key signifying whether the transfer is to be write or a function as well as other synchronization data. Data will be transferred to RMD in an unpacked mode (one record per sector) in order to avoid delays caused by unwritten still-to-be packed records. SPOOL file overflow messages will be output when appropriate after allowing the RMD circular file certain amounts of time to remove its oldest entry.

Figure 3-1 shows a simplified flow of output data through the SPOOL subsystem.



* WHERE n IS AN INTEGER FROM ZERO TO SEVEN

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Figure 3-1. Spooling Subsystem Flow

3.4.1 SPOOL Operation

During the system generation, up to eight spool pseudo devices may be defined. These pseudo-devices, SP0A through SP7A are dummies which can be assigned to any logical unit used only for output. Such assignments can be made permanently at SGEN time, or dynamically through JCP or OPCOM.

Each pseudo-device, SPiA, has a corresponding RMD file name, SPOOLi. These files must be defined on an RMD partition which is permanently assigned to logical unit 107 (named SX). Each spool pseudo-device and file is then associated with a logical unit (180-187) to which the LISTER writes unit record output. For example, a user issuing a WRITE request to an LUN assigned to device SPiA, will have data transferred to file SPOOLi on RMD.

The data will be read from the RMD and written to LUN 180 + i, whose name is Si, as time and the device allow.

If the output device is not busy when a user request is made, and if the RMD stream is inactive, the user data is moved directly to the output device via a SPOOL buffer. In this case, the user request is set complete as soon as the buffer is queued for the device.

If a user's I/O requests are made and a spool pseudo-device number for the appropriate SPOOLi file could not be found, of if the RMD is inoperative for any reason, the RMD is bypassed. That is, each user request causes a SPOOL buffer containing the user's data to be queued directly to the output device, up to a maximum of two buffers per stream. If the user should issue a request that would require a third buffer for that stream, then the SPOOL driver enters a delay loop until the two buffer limit can be satisfied. During this wait time, the user's I/O is active.

If the output device to which a user is spooling output should go down or become not ready, data continues to be accepted and spooled to RMD, but not more than two SPOOL buffers will be tied up waiting for the device to become usable. If an RMD is down when this case occurs, user's requests will be delayed after two buffers are allocated to the stream.

Should the user fill the RMD file for a stream with data before the device can catch up, the next user request remains active until space is available in the RMD.

3.4.2 SPOOL Files

Certain RMD files are required for maximum spooler operation. Without these, the SPOOL subsystem will function at a reduced rate. Files SPOOL0 through SPOOL7, where the last digit is the SPOOL stream number, are used as circular files and may be established at varying lengths to improve system performance. SPOOL operation will be slower if RMD files are totally filled with data to be output.

Files must be created after SGEN but before the first user of the SPOOL program. To establish files in a manner consistent with SPOOL, an exact procedure must be followed. If LO is assigned to SPOOL, it must be reassigned temporarily to a non-spooled device through OPCOM using a command such as:

```
;ASSIGN,LO=LP
```

where LP is not a spooled device. After this step, the actual file or files must be created using FMAIN in the following manner:

```
/FMAIN
INIT,107,S
CREATE,107,S,SPOOL0,120,n
CREATE,107,S,SPOOL1,120,n
.
.
.
CREATE,107,S,SPOOL7,120,n
/FINI
```

The last parameter n of the CREATE directives is the number of records. A CREATE directive is required for each data stream. As many CREATE directives as data streams are required.

The number of 120-word records to be established within the file is given as the last parameter of the CREATE directive. SPOOL files are circular files; entries are being placed on one end while being removed from the other end. When the SPOOL subsystem determines that the file is full, i.e., that another entry cannot be placed on the file without destroying one which has not been removed, transfers to the spooler driver will not be completed until a new file entry becomes available (the oldest entry has been removed from the file). As file size is increased, the likelihood of a full file is decreased. File size should be a function of expected stream utilization and device output speed, which determines how quickly entries are moved from circular spooler files. The 1060 error message indicates that a file is full. If this message is received frequently the number of records in that file should be increased for maximum spooling efficiency.

This procedure for creation of SPOOL files needs to be done only once. It is performed immediately after completion of SGEN when the "VORTEX SYSTEM READY" message is output. If these file sizes are found to be unsatisfactory, the system may be rebooted and file sizes modified by executing the procedure again.

As part of the SGEN for systems using the SPOOL program, controller table 0 (stream 0) must be included since the initialization routine is included in its buffers. Additional controller tables may be included as desired. However, storage requirements may be varied by using different controller tables: all even addresses contain four 74-word buffers, and odd streams contain only two 74-word buffers. For systems with a large amount of SPOOL throughput, it is recommended that four buffers be specified for controller tables, otherwise two-buffer tables should be sufficient.

3.5 I/O-CONTROL MACROS

I/O requests are written in assembly language programs as I/O macro calls. The DAS MR assembler provides the following I/O macros to perform I/O operations, thus simplifying coding:

•	OPEN	Open file
•	CLOSE	Close file
•	READ	Read one record
•	WRITE	Write one record
•	REW	Rewind
•	WEOF	Write end of file
•	SREC	Skip one record
•	FUNC	Function
•	STAT	Status
•	DCB	Generate data control block
•	FCB	Generate file control block

The IOC performs a validity check on all I/O requests. It then queues (according to the priority of the requesting task) each valid request to the controller assigned to the specified logical unit. Finally, the IOC schedules the appropriate I/O driver to service the queued request.

The assembler processes the I/O macro to yield a macro expansion comprising data and executable instructions in the form of assembler language statements.

Certain I/O operations require parameters in addition to those in the I/O macro. These parameters are contained in a table, which, according to the operation requested, is called either a file control block (FCB, section 3.5.11) or a data control block (DCB, section 3.5.10). Embedded but omitted parameters (e.g., default values) must be indicated by the normal number of commas.

Error messages applicable to these macros are given in Appendix A.3.

I/O Macros: *The general form of I/O macros is:*

```
label     name     cb,lun,wait,mode
```

where the symbols have the definitions given in section 3.5.1.

If the **cb** is for an FCB, it is mandatory. If it is for a DCB, it is optional.

The expansion of an I/O macro is:

<table>
<tr><th>Bit</th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Word 0</td><td colspan="16">J S R,X</td></tr>
<tr><td>Word 1</td><td colspan="16">0404</td></tr>
<tr><td>Word 2</td><td>c</td><td colspan="6">Status</td><td>e</td><td colspan="3">cc</td><td colspan="5">Priority*</td></tr>
<tr><td>Word 3</td><td>w</td><td colspan="3">Mode</td><td colspan="4">Op code</td><td colspan="8">Logical unit number</td></tr>
<tr><td>Word 4</td><td colspan="16">FCB or DCB address</td></tr>
<tr><td>Word 5</td><td colspan="16">User task identification block address*</td></tr>
<tr><td>Word 6</td><td colspan="16">IOC thread address*</td></tr>
</table>

where

c set indicates completion of I/O tasks

Status is the status of the I/O request

e set indicates an irrecoverable I/O error

cc is the completion code

Priority is the priority level of the task making the request

w is the wait/immediate-return option

Mode is the mode of operation

Op-code specifies the I/O operation to be performed

* indicates an item whose initial value is zero

The wait option causes the task to be suspended until its I/O is complete. The immediate option causes control to be returned immediately to the task after the I/O request is queued. Therefore, to multiprogram effectively within VORTEX, the wait option is preferred.

Word 2 contains the following information:

a. Bit 15 indicates whether the I/O request is complete.

b. Bits 14 through 9 contain one of the error-message status codes described in Appendix B.2.

c. Bit 8 indicates an irrecoverable I/O error.

d. Bits 7 through 5 contain a completion code: 000 indicates a normal return; 101, an error; 110, an end of file, beginning of device, or beginning of tape; and 111, end of device, or end of tape.

e. Bits 4 through 0 indicate the priority level of the task making the request.

Word 3 contains the following information:

Bits 0-7 Logical Unit (LUN)

When an I/O request is made to VIOC, VIOC uses the LUN as an index into the logical unit table (LUT). V$IOC then uses the current assignment pointer of that entry in the LUT to determine the address of the DST on which the I/O is to be performed. To determine the DST address, the current assignment value less one is multiplied by the length of a DST (3 words) and added to the base address of the DST block. V$IOC verifies the validity of the specified LUN.

If the LUN is invalid, a parameter error has occurred (refer to sections 3.1 and 3.3).

Bits 8-11 Op-Code

Op-codes can range in value from 0 to 15; however, not all op-codes are applicable for every device. V$IOC, using the op-code as an index gets an entry from a bit table. This word contains a 1 in the bit position associated with the op-code and is compared with the controller table item CTOPM. If the corresponding bit in CTOPM is set to 1, it means that the device connected to the controller can perform the requested operation. If the corresponding bit in CTOPM is zero, the I/O request is not performed, and the I/O complete indicator (bit 15) set.

Bit 8-11	**Meaning**
0000	Read
0001	Write
0010	Write EOF
0011	Rewind
0100	Skip record
0101	Function
0110	Open
0111	Close
1000-1111	Not used

Bits 12-14 Mode

The mode bits are not used by V$IOC nor V$FNR. The I/O driver use this information whenever applicable to the op-code.

Bit 15 Wait Option

V$IOC uses this bit to determine whether the requesting task is to be suspended until I/O is completed or whether an immediate return is required.

Bit 15 = 0 Suspend until I/O completed. V$IOC sets bit 14 in TBST in the requesting task's TIDB.

Bit 15 = 1 Immediate return required (via V$DISP). V$IOC clears bit 14 in TBST in the requesting task's TIDB.

Word 5 initially points to the user's task identification block. Upon completion of a READ or WRITE macro (sections 3.5.3 and 3.5.4), the IOC sets word 5 to the actual number of words transmitted.

Status macro: *The general form of the status (STAT) macro* is:

label **STAT** **req,err,aaa,bbb,busy**

where the symbols have the definitions given in section 3.5.9.

The normal return is to the first word following the macro expansion.

The expansion of the STAT macro is:

Bit	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Word 0	J S R,X
Word 1	0373
Word 2	Address of the I/O macro
Word 3	Address of the I/O error routine
Word 4	aaa
Word 5	bbb
Word 6	Address of the busy or I/O-not-complete routine

where **aaa** is the address of the end of file, beginning of device or beginning of the tape routine and **bbb** is the address of the end of the tape or end of the device routine.

Control block macro: *The general form of the DCB macro* is:

label **DCB** *rl,buff,fun*

where the symbols have the definitions given in section 3.5.10.

The expansion of the DCB macro is:

Bit	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Word 0	Record length
Word 1	Direct Address of user data area
Word 2	Function code

The function code applies only to I/O drivers that allow:

a. The line printer to slew to top of form or to space through the channel selection for paper-tape form control.

b. The paper-tape punch to punch leader.

c. The card punch to eject a blank card as a separator.

The general form of the FCB macro is:

label **FCB** *rl,buff,acc,key,'xx','yy','zz'*

where the symbols have the definitions given in section 3.5.11.

The expansion of the FCB macro is:

Bit	15 14 13 12 11 10 9 8	7 6 5 4 3 2 1 0
Word 0	Record length	
Word 1	Address of user data area	
Word 2	Access method	Protection key
Word 3	Current record number	
Word 4	Current end-of-file address	
Word 5	Beginning file address	
Word 6	Ending file address	
Word 7	File name	
Word 8	File name	
Word 9	File name	

The access method (word 2, bits 15 through 8) specifies one of the four methods of reading or writing a file:

a. *Direct access by logical record:* The I/O driver uses the contents of FCB word 3 as the number of the logical record within a file to be processed, but does not alter word 3 after reading or writing. Word 3 is set by the user to the desired record number prior to each read/write.
Specifying FCB word three to zero will cause access to the partition directory. Care should be taken when supplying this value so that directories are not accidentally destroyed.

b. *Sequential access by logical record:* The I/O driver uses the contents of word 3 as the number of the logical record within a file to be processed, then increments the contents of word 3 by one. Word 3 is set initially to zero when the FCB macro expands. Successive reading and writing thus accesses records sequentially.

c. *Direct access by physical record:* The I/O driver uses the contents of FCB word 3 as the number of the VORTEX physical record to be processed within a file (120-word length), but does not alter word 3 after a read or write. Word 3 is set by the user to the desired record number prior to each read/write.
Specifying FCB word three to zero will cause access to the partition directory. Care should be taken when supplying this value so that directories are not accidentally destroyed.

d. *Sequential access by physical record:* The I/O driver uses the contents of FCB word 3 as the number of the VORTEX physical record to be processed within a file (120-word length), then increments the contents of word 3 by one. Word 3 is set initially to zero when the FCB macro expands. Successive reading and writing thus accesses records sequentially.

3.5.1 OPEN Macro

This macro, which applies only to RMDs or magnetic-tape units, enables I/O operations on the devices by initializing the file information in the specified FCB. The macro has the general form

label   **OPEN**   **fcb,lun,***wait*,*mode*

where

fcb is the address of the file control block

lun is the number of the logical unit being opened

wait is 1 for an immediate return, or 0 (default value) for a return suspended until the I/O is complete

mode is 0 (default value) for rewinding or 1 for not rewinding. In the former case, word 3 (current record number) of the FCB is set to 1, word 4 (current position-of-file address) is set to the current position-of-file address given by the RMD file directory, and rewinds the magnetic-tape unit. In the latter case, the current position-of-file address given by the RMD file directory is copied into word 4, converted to a record number and stored in word 3 of the FCB, thus initializating the user FCB, enabling reading or writing from a previously specified location, and the magnetic-tape position is left unchanged (not rewound).

OPEN must precede any other I/O request (except REW) because the FCB file information must be complete before any file oriented I/O is possible. If a file has already been opened, an OPEN will be accepted.

The OPEN macro is file-oriented, while the REW macro is oriented to the logical unit. An REW destroys information completed by a previous OPEN on the same logical unit.

The OPEN macro changes words 3, 4, 5, and 6 of the FCB (section 3.5.11).

If an attempt is made to apply the OPEN macro to any device other than an RMD or a magnetic-tape unit, the I/O request is processed internally by the IOC but not by an I/O driver. The IOC indicates the status as I/O complete.

Example: Read a 120-word record from the FI10 on logical unit 18, an RMD partition with sequential, record-oriented access. BUFF is the address of the user's buffer area. Use the wait and rewind options, and set the logical-unit protection key to 1.

```
X1     EQU    18     (LUN assigned to unit X1)
RL     EQU    120    (Record length 120)
WAIT   EQU    0      (Wait option)
REW    EQU    0      (Rewind option)
KEY    EQU    1      (Logical-unit protection key)
SEQR   EQU    1      (Sequential, record-oriented
                     access)
OPEN   OPEN   FCB,X1,WAIT,REW
READ   READ   FCB,X1,WAIT
       .
       .
       .
FCB    FCB    RL,BUFF,SEQR,KEY,
                 'FI','10',' '
```

3.5.2 CLOSE Macro

This macro, which applies only to RMDs or magnetic-tape units, updates information in the specified FCB file. This records and retains the current position within the file. The *mode* option ignores the updating, thus retaining the previously defined position in the file. The macro has the general form

label   **CLOSE**   **fcb,lun,***wait*,*mode*

where

fcb is the address of the FCB

lun is the number of the logical unit being closed

wait is 1 for an immediate return, or 0 (default value) for a return suspended until the I/O is complete *mode* is 0 (default value) for not updating, or 1 for updating In the former case, there is no change to the current position-of-file address in the RMD file directory, words 3, 4, 5, and 6 of the FCB are set to zero, and the magnetic-tape position is left unchanged (not rewound). In the latter case, the contents of FCB word 3 (current record number) are converted to an address and stored in the current position-of-file address in the RMD file directory, words 3, 4, 5, and 6 of the FCB are set to zero, and an end-of-file mark written on the magnetic tape.

The CLOSE macro cannot be used if there is no such file defined in the FCB (section 3.5.11).

If an attempt is made to apply the CLOSE macro to any device other than an RMD or magnetic-tape unit, the I/O request is processed internally by the IOC, but not by an I/O driver. The IOC indicates the status as I/O complete.

Example: Close the file MATRIX on logical unit 180, an RMD partition with sequential, record-oriented access. Use the wait and update options.

```
SEQR    EQU     1         (Sequential, record-
                          oriented access)
UPDATE  EQU     1         (Update option)
WAIT    EQU     0         (Wait option)
        .
        .
        .
CLOSE   CLOSE   FCB,180,WAIT,UPDATE
        .
        .
        .
FCB     FCB     ,,SEQR,,'MA','TR','IX'
```

3.5.3 READ Macro

This macro retrieves a record of specified length from the specified logical unit, and places it in the specified area of main memory. The macro has the general form

label **READ** cb,lun,wait,mode

where

cb is the address of the data control block, or of the file control block

lun is the number of the logical unit from which the record is read

wait is 1 for an immediate return, or 0 (default value) for a return suspended until the I/O is complete

mode **specifies the I/O mode: 0 (default value) for system binary, 1 for ASCII, 2 for BCD, or 3 for unformatted I/O (see appendix C for format)**

The number of words read is stored in word 5 of the I/O macro.

Example: Read a record from logical unit 4, a magnetic tape unit. Use system binary mode and the immediate return option. The record length is 60 words, and the address of the user's data area is BUFF.

```
IM      EQU     1         (Immediate return)
BIN     EQU     0         (System binary mode)
MT      EQU     4         (LUN assigned to
                          magnetic-tape unit)
RECL    EQU     60        (Record length 60 words)
        .
        .
        .
MTRD    READ    TAPE,MT,IM,BIN
        .
        .
        .
TAPE    DCB     RECL,BUFF  (Data control block)
BUFF    BSS     60         (User data area)
```

Note that the READ macro had a mode value of zero. Since this is the default value, the macro could have been coded:

```
MTRD    READ    TAPE,MT,IM
```

3.5.4 WRITE Macro

This macro takes a record of specified length from the specified area of main memory, and transmits it to the specified logical unit. The macro has the general form

label **WRITE** cb,lun,*wait,mode*

where the parameters have the same definitions and take the same values as in the READ macro (section 3.5.3).

The number of words written is stored in word 5 of the I/O macro. The first byte of each print line is treated as a print control character and not echoed when outputting to a listing device.

Example: Obtain a system binary record 60 words in length from the user's data area BUFF, and transmit it to logical unit 16, a magnetic-tape unit. Use the immediate return option.

```
IM      EQU     1         (Immediate return)
BIN     EQU     0         (System binary mode)
MT      EQU     16        (LUN assigned to magnetic
                          tape unit)
RECL    EQU     60        (Record length 60 words)
        .
        .
        .
MTWT    WRITE   TAPE,MT,IM,BIN
        .
        .
        .
TAPE    DCB     RECL,BUFF  (Data control block)
BUFF    BSS     60         (User data area)
```

3.5.5 REW (Rewind) Macro

This macro, which applies only to magnetic-tape or rotating-memory devices, repositions the specified logical unit to the beginning-of-unit position. It has the general form

```
        label       REW         cb,lun,wait
```

where

cb is the address of the FCB or DCB, which is optional

lun is the number of the logical unit being rewound

wait is 1 for an immediate return, or 0 (default value) for a return suspended until the I/O is complete

Note that the DCB address is an optional parameter, but that the FCB address is mandatory.

To reposition a named file on an RMD, use the OPEN macro (section 3.5.1).

Magnetic-tape devices: REW rewinds the specified unit and, upon successful completion of the task, returns a beginning-of-device (BOD) status.

Rotating-memory devices REW places the start-RMD-partition and end-RMD-partition addresses in words 5 and 6, respectively, of the FCB (section 3.5.11).

Examples: Rewind logical unit 23, a magnetic-tape unit. Use the wait option, here specified by default.

```
MT        EQU       23        (LUN assigned to magnetic
                              tape unit)
           .
           .
           .
REWT      REW       ,MT
           .
           .
           .
```

Rewind logical unit 10, an RMD partition. Use the wait option, here specified by default. Note that the REW for an RMD must have an associated FCB (section 3.5.11).

```
DISC      EQU       10        (LUN assigned to RMD
                              partition)
RECL      EQU       120
           .
           .
           .
REWD      REW       FCB,DISC
           .
           .
           .
FCB       FCB       RECL,BUFF,,,'SY','ST','EM'
                    (section 3.5.11)
BUFF      BSS       120
```

3.5.6 WEOF (Write End of File) Macro

This macro writes an end of file on the specified logical unit. It has the general form

```
        label       WEOF        cb,lun,wait
```

where

cb is the address of the control block

lun is the number of the affected logical unit

wait is 1 for an immediate return, or 0 (default value) for a return suspended until the I/O is complete

Example: Write an end of file on logical unit 10. Use the wait option, here specified by default.

```
TAPE      EQU       10
           .
           .
           .
EOF       WEOF      CB,TAPE
           .
           .
           .
```

3.5.7 SREC (Skip Record) Macro

This macro, which applies only to magnetic-tape, card reader, or rotating-memory devices, skips one record in either direction on the specified logical unit. It has the general form

```
        label       SREC        cb,lun,wait,mode
```

where

cb is the address of the control block

lun is the number of the logical unit being manipulated

wait is 1 for an immediate return, or 0 (default value) for a return suspended until the I/O is complete

mode specifies the direction of the skip: 0 (default value) for a forward skip, or 1 for a reverse skip. Reverse skip does not apply to the card reader.

If applied to an RMD, SREC adds or subtracts from the value of word 3 of the FCB (section 3.5.11).

If an attempt is made to apply this macro to a device other than a magnetic-tape or rotating-memory unit, the I/O request is processed internally by the IOC but not by an I/O driver. The IOC indicates the status as I/O complete.

Example: Skip back one record on logical unit 57, a magnetic-tape unit. Use the immediate-return option.

```
MT       EQU      57   (LUN assigned to magnetic-
                        tape unit)
REV      EQU      1    (Reverse)
IM       EQU      1    (Immediate return)
         .
         .
SKIP     SREC     CB,MT,IM,REV
         .
         .
```

3.5.8 FUNC (Function) Macro

This macro performs a miscellaneous function on a specified logical unit. The function (when present) cannot be defined by any of the preceding I/O control functions. The macro has the general form

label **FUNC** **dcb,lun,*wait***

where

dcb — is the address of the data control block

lun — is the number of the logical unit being manipulated

wait — is 1 for an immediate return, or 0 (default value) for a return suspended until the I/O is complete

FUNC causes certain I/O drivers to perform special functions specified by the function code *fun* in a DCB macro (section 3.5.10):

I/O Driver	Function Code	Function
Card punch	0	Eject blank card
Paper-tape punch	0	Punch 256 blank frames for leader
Line printer and Teletype printer	0	Advance paper to top of next form, or on Teletype 3 lines x
	1	Advance paper one line
	2	Advance paper two lines
Statos 31	7	Advance paper to bottom of form
	8	Normal print size*
	9	Large print size*

*Only for software character generator.

I/O Driver	Function Code	Function
Statos 31/42	00	Advance paper to top of form
	01	Advance paper one line
	02	Advance paper two lines
	07	Advance paper to bottom of form
	08	Step plotter one raster line
	10	Select small/upright
	11	Small/ +90 degrees
	12	Small/ 180 degrees
	13	Small/−90 degrees
	14	Large/upright
	15	Large/ +90 degrees
	16	Large/ 180 degrees
	17	Large/−90 degrees
	20	Cut paper
	21	End cut

Plot data may be transmitted to the Statos 31 by specifying unformatted mode, 3, in the WRITE macro. Each 1 bit will cause a dot to be printed in its corresponding position in the output line. The most significant bit in the first word output represents the left-most dot position.

Statos 31/42 — The WRITE macro enables the transfer of one data buffer to the printer/plotter and allows for five different modes of operation:

Mode 1 --	Compatible line printer (70-6701) mode
Mode 3 --	Plot (raster) mode (binary raster data transfer)
Mode 4 --	Print mode selectable size and orientation
Mode 5 --	Simultaneous print/plot mode (ASCII data transfer)
Mode 6 --	Simultaneous print/plot mode (binary raster data)

All other modes default to mode 1.

If an attempt is made to apply the FUNC macro to any other device, the I/O request is processed internally by the IOC but not by an I/O driver. The IOC indicates the status as I/O complete.

Example: Skip two lines on the printer, which is logical unit 5. Use the wait option, here specified by default.

```
LP      EQU     5       (LUN assigned to line
CNT     EQU     2       printer) (Paper-tape
                        channel 2)
        .
        .
        .
UPSP    FUNC    DCB,LP
        .
        .
        .
DCB     DCB     ,,CNT
```

3.5.9 STAT (Status) Macro

This macro examines the status word in an I/O macro to determine the result of an I/O function request. The STAT macro has the general form

label **STAT** **req,err,aaa,bbb,busy**

where

req is the address of the I/O macro (e.g., READ)

err is the address of the I/O-error routine

aaa is the address of the end of file, beginning of device, or beginning of tape routine

bbb is the address of the end of device or end of tape routine

busy is the address of the I/O-not-complete routine

All parameters (except the label) are mandatory. The contents of the overflow indicator and the A and B registers are saved. Upon normal completion, control returns to the user at the first word after the end of the macro expansion.

CAUTION

Foreground tasks should not loop to check for completion of I/O tasks because this inhibits all lower-level tasks.

Example: Rewind logical unit 12, a magnetic-tape unit, and check for beginning of device (load point). Use the immediate-return option.

```
MT      EQU     12      (LUN assigned to magnetic-
                        tape unit)
IM      EQU     1       (Immediate return)
        .
        .
REW     REW     ,MT,IM  (DCB can be omitted
                          for REW)
        .
        .
        .
BUSY    STAT    REW,ERR,BOT,EQT,BUSY
        .
        .
        .
BOT
        .
        .
        .
ERR
```

3.5.10 DCB (Data Control Block) Macro

This macro generates a DCB as required by I/O macro requests to devices other than RMDs. Note that not all such requests (e.g., rewinding a magnetic-tape unit) require a DCB. The macro has the general form

label **DCB** *rl,buff,fun*

where

rl is the length, in words, of the record to be transmitted

buff is the address of the user's data area

fun is the function code for a FUNC request and is unused for other requests (section 3.5.8)

Example: Read a record from logical unit 4, a magnetic-tape unit. Use system binary mode and the immediate-return option. The record length is 60 words, and the address of the user's data area is BUFF.

```
IM      EQU     1       (Immediate return)
BIN     EQU     0       (System binary mode)
MT      EQU     4       (LUN assigned to magnetic-
                        tape unit)
RECL    EQU     60      (Record length 60 words)
        .
        .
        .
MTRD    READ    TAPE,MT,IM,BIN
        .
        .
        .
TAPE    DCB     RECL,BUFF (Data control block)
```

3.5.11 FCB (File Control Block) Macro

This macro generates an FCB required by any I/O macro request to an RMD. The macro has the general form

label **FCB** *rl,buff,acc,key,'xx','yy','zz'*

where

rl is the length, in words, of the record to be transmitted

buff is the address of the user's data block

acc specifies the access method and is 0 (default value) for the direct access by logical record, 1 for sequential access by logical record, 2 for direct access using the relative sector number (beginning with 1) within the file, or 3 for sequential access using the relative sector number within the file

key is the protection code, if any, required to address that logical unit. This is a single alphanumeric ASCII character coded between single quotation marks (e.g., the protection code H would be coded 'H') or as the eight-bit octal equivalent, in which case no quotation marks are used (e.g., 0310 for the protection code H). The default value is binary zero (not the character 0).

xxyyzz is the name of the file being referenced. The file name is one to six ASCII characters, coded in pairs between single quotation marks and separated by commas, e.g., the file named ARRIBA is coded 'AR' ,'RI' , 'BA' . Embedded blanks are illegal.

Table 3-3 shows the use of FCB words 3, 4, 5, and 6 for the I/O macros.

Example: Create an FCB for the file FILEXX. Use the logical-record-oriented, sequential-access method with a record length of 120 words. The user's data area is BUFF and the protection code is Z.

```
SEQR     EQU      1        (Sequential, record-
                           oriented access)
RECL     EQU      120      (Record length 120
           .                words)
           .
           .
DISC     FCB      RECL,BUFF,SEQR,'Z',
           .      'FI','LE','XX'
           .
           .
BUFF     BSS      120
```

Note that the protection code character Z is coded between single quotation marks, i.e., 'Z', but it can also be coded as the octal value of the ASCII character, in which case no quotation marks are used, i.e., 0332. Thus, the statement given in the example above is equivalent to

```
DISC        FCB         RECL,BUFF,SEQR,
                        0322,'FI','LE','XX'
```

Table 3-3. FCB Words Under I/O Macro Control

Word	OPEN	READ	WRITE	SREC	CLOSE	REW
			Sequential-Access Method			
3	Set to position of current record by mode chosen	Increments record number by one	Increments record number by one	Adds or subtracts one	Put into position of file on directory by mode chosen	Current record set (directory partition) to one or beginning address of logical unit (non-directory partition)
4	Set to current position of file as noted on directory	Checks end of file	No action	Checks end of file	Cleared	Set to ending address of logical unit

Table 3-3. FCB Words Under I/O Macro Control *(continued)*

Word	OPEN	READ	WRITE	SREC	CLOSE		REW
5	Set to beginning of file address put in this word	No action	No action	No action	Cleared	Set to beginning address of logical unit (non-directory partition)	Skip first directory sector (directory partition)
6	Set to end of file address	No action	No action	No action	Cleared	Set to ending address of logical unit	
			Direct-Access Method				
3	Set to position of current record by mode chosen	No action	No action	No action	Put into position of file on directory by mode chosen	Current record set (directory partition) to one or beginning address of logical unit (non-directory partition)	
4	Set to current position of file as noted on directory	No action	No action	No action	Cleared	Set to ending address of logical unit	
5	Set to beginning of file address	No action	No action	No action	Cleared	Set to beginning address of logical unit (non-directory partition)	Skip first directory sector (directory partition)
6	Set to end of file address	No action	No action	No action	Cleared	Set to ending address of logical unit	

SECTION 4
JOB-CONTROL PROCESSOR

The **job-control processor** (**JCP**) is a background task that permits the scheduling of VORTEX system or user tasks for background execution. The JCP also positions devices to required files, and makes logical-unit and I/O-device assignments.

4.1 ORGANIZATION

The JCP is scheduled for execution whenever an unsolicited operator key-in request to the OC logical unit has a slash (/) as the first character.

Once initiated, the JCP processes all further JCP directives from the SI logical unit.

If the SI logical unit is a Teletype or a CRT device, the message **JC**** is output to indicate the SI unit is waiting for JCP input. The operator is prompted every 15 seconds (by a bell for the Teletype or tone for the CRT) until an input is keyed in.

If the SI logical unit is a rotating-memory-device (RMD) partition, the job stream is assumed to comprise unblocked data. In this case, processing the job stream requires an /ASSIGN directive (section 4.2.6).

A JCP directive has a maximum of 80 characters, beginning with a slash. Directives input on the Teletype are terminated by the carriage return.

All JCP directives are echoed to the SO logical unit if SI ≠ SO. All directives, except /C and /P have the time of day append onto the front of the directive when echoed to SO. The format is

HH:MM:SS **/JCP** *directive*

4.2 JOB-CONTROL PROCESSOR DIRECTIVES

This section describes the JCP directives:

a. Job-initiation/termination directives:

/JOB	Start new job
/ENDJOB	Terminate job in progress
/FINI	Terminate JCP operation
/C	Comment
/P	Pause
/MEM	Allocate extra memory for background task

b. I/O-device assignment and control directives:

/ASSIGN	Make logical-unit assignment(s)
/SFILE	Skip file(s) on magnetic-tape unit
/SREC	Skip record(s) on magnetic-tape unit or RMD partition
/WEOF	Write end-of-file mark
/REW	Rewind magnetic-tape unit or RMD partition
/PFILE	Position rotating memory-unit file
/FORM	Set line count on LO logical unit
/KPMODE	Set keypunch mode
/OPEN	Open VTAM line or terminal
/CLOSE	Close VTAM line or terminal
/CFILE	Close file on global logical unit

c. Language-Processor directives:

/DASMR	Schedule DAS MR assembler
/FORT	Schedule FORTRAN compiler

d. Utility directives:

/CONC	Schedule system-concordance program
/SEDIT	Schedule symbolic source-editor task
/FMAIN	Schedule file-maintenance task
/LMGEN	Schedule load-module generator
/IOUTIL	Schedule I/O-utility processor
/SMAIN	Schedule system-maintenance task

e. Program-loading directives:

/EXEC	Schedule loading and execution of a load-module from the SW unit file
/LOAD	Schedule loading and execution of a user background task
/ALTLIB	Schedule the next background task from the specified logical unit rather than from the background library
/DUMP	Dump background at completion of task execution

JCP directives begin in column 1 and comprise sequences of character strings having no embedded blanks. The character strings are separated by commas (,) or by equal signs (=). The directives are free-form and blanks are permitted between the individual character strings of the directive, i.e., before or after commas (or equal signs). Although not required, a period (.) is a line terminator. Comments can be inserted after a period.

Each JCP directive begins with a slash (/).

The general form of a job-control statement is

/name,*p(1)*,*p(2)*,...,*p(n)*

where

name is one of the directive names given (any other character string produces an error)

each *p(n)* is a parameter required by the JCP or by the scheduled task and defined below under the descriptions of the individual directives

Numerical data can be octal or decimal. Each octal number has a leading zero.

For greater clarity in the descriptions of some directives, optional periods, optional blank separators between character strings, and the optional replacement of commas by equal signs are omitted from descriptions.

Error messages applicable to JCP directives are given Appendix A.4.

4.2.1 /JOB Directive*

This directive initializes all background system pointers and flags, and stores the job name if one is specified. It has the general form

/JOB,*name*

where name is the name of the job and comprises up to eight ASCII characters (additional characters are permitted but ignored by the JCP).

The job name, if any, is then printed at the top of each page for all VORTEX background programs.

The occurrence of the /JOB directive causes the scheduling of the background task V$ACT1. V$ACT1 is a dummy task on BL which only performs an EXIT. However, V$ACT1 may be replaced by a user task to perform any desired accounting function.

Example: Initialize the job TASKONE.

```
/JOB,TASKONE
```

4.2.2 /ENDJOB Directive*

This directive initializes all background system pointers and flags, and clears the job name. It has the form

/ENDJOB

The occurrence of the /ENDJOB directive causes the scheduling of the background task V$ACT2. V$ACT2 is a dummy task on BL which only performs an EXIT. However, V$ACT2 may be replaced by a user task to perform any desired accounting function.

Example: Terminate the job in process.

```
/ENDJOB
```

4.2.3 /FINI (Finish) Directive*

This directive terminates all JCP background operations and makes an EXIT request to the real-time executive RTE component (section 2.1.11). It has the form

/FINI

To reschedule JCP after a FINI, input any JCP directive from the OC unit

The occurrence of the /FINI directive causes the scheduling of the background task V$ACT3. V$ACT3 is a dummy task on BL which only performs an EXIT. However, V$ACT3 may be replaced by a user task to perform any desired accounting function.

Example: Terminate JCP operations.

```
/FINI
```

* The JCP directives JOB, ENDJOB, and FINI reset all logical units and table 1 units to their default (system) values. JOB and ENDJOB do not set the SI logical unit.

4.2.4 /C (Comment) Directive

This directive outputs the specified comment to the SO and LO logical units, thus permitting annotation of the listing. It is not otherwise processed. It has the general form

/C,*comment*

where **comment** is any desired free-form comment.

Example: Annotate a listing with the comment *Rewind all mag tapes*.

```
/C,REWIND ALL MAG TAPES
```

4.2.5 /MEM (Memory) Directive

This directive assigns additional 512-word blocks of main memory to the next scheduled background task. It has the general form

/MEM,n

where **n** is the number of 512-word blocks of main memory to be assigned.

/MEM permits larger symbol tables for FORTRAN compilations and DAS MR assemblies.

The total area of the 512-word blocks of memory plus the background program itself cannot be greater than the total area available for background and nonresident foreground tasks. An attempt to exceed this limit causes the scheduled task to be aborted.

Example: Allocate an additional 1,024 words of main memory to the next scheduled task.

```
/MEM,2
```

4.2.6 /ASSIGN Directive

This directive equates and assigns particular logical units to specific I/O devices. It has the general form

/ASSIGN,l(1)=r(1),*l(2)=r(2), ...,l(n)=r(n)*

where

each **l(n)** is a logical-unit number (e.g., 102) or name (e.g., SI)

each **r(n)** is a logical-unit number or name, or a physical-device system name (e.g., TY00, table 17-1)

The logical unit to the left of the equal sign in each pair is assigned to the unit/device to the right.

If the controller and unit numbers are omitted from the name of a physical device, controller 0 and unit 0 are assumed.

An inoperable device, i.e., one declared down by the ;DEVDN operator key-in request (section 17.2.10), cannot be assigned. A logical unit designated as unassignable cannot be reassigned.

Example: Assign the PI logical unit to card reader CR00 and the LO logical unit to Teletype TY00.

```
/ASSIGN,PI=CR,LO=TY
```

4.2.7 /SFILE (Skip File) Directive

This directive, which applies only to magnetic-tape units and card readers, causes the specified logical unit to move the tape forward the designated number of end-of-file marks. It has the general form

/SFILE,lun,neof

where

lun is the number or name of the affected logical unit

neof is the number of end-of-file marks to be skipped

If the end-of-tape mark is encountered before the required number of files has been skipped, the JCP outputs to the SO and LO logical units the error message **JC05,nn**, where **nn** is the number of files remaining to be skipped.

Example: Skip three files on the BI logical unit.

```
/SFILE,BI,3
```

4.2.8 /SREC (Skip Record) Directive

This directive, which applies only to magnetic-tape units, card readers, and RMDs, causes the specified logical unit to move the tape the designated number of records in the required direction. In the case of RMDs, word 4 of the FCB is adjusted the appropriate number of records. It has the general form

/SREC,lun,nrec,*direc*

where

lun is the number or name of the affected logical unit

nrec is the number of records to be skipped

direc indicates the direction to be skipped; F (default value) for forward, or R for reverse. Reverse skip does not apply to the card reader.

If a file mark, end of tape, or beginning of tape is encountered before the required number of records has been skipped, the JCP outputs to the SO and LO logical units the error message **JC05,nn**, where **nn** is the number of records remaining to be skipped.

Example: Skip nine records forward on the BO logical unit.

```
/SREC,BO,9
```

4.2.9 /WEOF (Write End of File) Directive

This directive writes an end-of-file mark on the specified logical unit. It has the general form

/WEOF,lun

where **lun** is the number or name of the affected logical unit. (Not accepted for RMD.)

Example: Write an end-of-file mark on the BO logical unit.

```
/WEOF,BO
```

4.2.10 /REW (Rewind) Directive

This directive, which applies only to magnetic-tape units and RMDs, causes the specified logical unit(s) to rewind to the beginning of tape. It has the general form

/REW,lun,*lun,...,lun*

where **lun** is the number or name of a logical unit to be rewound.

Example: Rewind the BO and PI logical units.

```
/REW,BO,PI
```

4.2.11 /PFILE (Position File) Directive

This directive, which applies only to RMDs and MT assigned to global logical units causes the specified logical unit to move to the beginning of the designated file. It has the general form

/PFILE,lun,*key,name*

where

lun is the number or name of the affected logical unit. The logical unit must be one of the system defined logical units which has a global FCB

key is the protection code required to address **lun**

name is the name of the file to which the logical unit is to be positioned

Global file control blocks: There are eight global file control blocks (FCB, section 3.5.11) in the VORTEX system that are reserved for background use. System background and user programs can reference these global FCBs. The /PFILE directive stores *key* and *name* in the corresponding FCB before opening/rewinding the logical unit. To pass the buffer address and size of the record to the corresponding logical-unit FCB, make an RTE IOLINK service request (section 2.1.13). The names of the global FCBs are *SIFCB, PIFCB, POFCB, SSFCB, BIFCB, BOFCB, GOFCB,* and *LOFCB,* where the first two letters of the name indicate the logical unit.

/PFILE,lun,key,name

where

lun is the number or name of the affected logical unit. The logical unit must be one of the system defined logical units which has a global FCB

key is the protection code required to address **lun**

name is the name of the file to which the logical unit is to be positioned

Global file control blocks: There are eight global file control blocks (FCB, section 3.5.11) in the VORTEX system that are reserved for background use. System background and user programs can reference these global FCBs. The /PFILE directive stores **key** and **name** in the corresponding FCB before opening/rewinding the logical unit. To pass the buffer address and size of the record to the corresponding logical-unit FCB, make an RTE IOLINK service request (section 2.1.13). The names of the global FCBs are *SIFCB, PIFCB, POFCB, SSFCB, BIFCB, BOFCB, GOFCB,* and *LOFCB,* where the first two letters of the name indicate the logical unit.

Example: Position the PI logical unit to beginning of file FILEXY, whose protection key is $.

```
/PFILE,PI,$,FILEXY
```

4.2.12 /FORM Directive

This directive sets the specified line count on the LO logical unit. This is the number of lines printed by DAS MR assembler or FORTRAN compiler before a top of form is issued. The directive has the general form

/FORM,lines

where **lines** is the number (from 5 to 9999, inclusive) of lines to be printed before a top of form is issued.

The default value of **lines** is defined at system-generation time. If the directive contains a value outside the legal range, the default value is used.

Example: Set a line-count value of 100.

```
/FORM,100
```

4.2.13 /KPMODE (Keypunch mode) Directive

This directive specifies the mode, 026 or 029, (BCD or EBCDIC respectively) in which VORTEX is to read and punch cards. It has the general form

KPMODE,m

where m is 0 for 026 mode, or 1 for 029 mode.

Example: Specify that cards be read and punched in 029 keypunch mode.

```
/KPMODE,1
```

4.2.14 /DASMR (DAS MR Assembler) Directive

This directive schedules the DAS MR assembler (section 5.1) with the specified options for background operation on priority level 1. It has the general form

/DASMR,*p(1)*,*p(2)*,. . .,*p(n)*

where each *p(n)*, if any, is a single character specifying one of the following options:

Parameter	Presence	Absence
B	Suppresses binary object	Output binary object
L	Outputs binary object on GO file	Suppresses output of binary object on GO file
M	Suppresses symbol-table listing	Output symbol-table listing
N	Suppresses source listing	Outputs source listing
E	Assembles V75 extended instructions.	Flags V75 extended instructions with '*OP error'.
I	Flags implicit indirect instructions with '*II error'.	Assembles implicit indirect instructions.

The /DASMR directive can contain up to four such parameters in any order.

The DAS MR assembler reads source records from the PI logical unit on the first pass. The PI unit must have been set to the beginning of device before the /DASMR directive. This can be done with an /ASSIGN (section 4.2.6), /SFILE (section 4.2.7), /REW (section 4.2.10), or /PFILE (section 4.2.11) directive.

A load-and-go operation requires, in addition, an /EXEC directive (section 4.2.22).

Example: Schedule the DAS MR assembler with no source listing, but with binary-object output on the GO file.

```
/JOB,EXAMPLE
/PFILE,BO,,BO
/DASMR,N,L
```

/JOB initializes the GO file to start of file. If BO is assigned to a rotating memory partition, a /PFILE,BO,,BO must precede the /DASMR directive to initialize the file (unless the assembly is part of a stacked job - see section 4.3 for sample deck setup).

4.2.15 /FORT (FORTRAN Compiler) Directive

This directive schedules the FORTRAN compiler (section 5.3) with the specified options for background operation on priority level 1. It has the general form

/FORT,*p(1)*,*p(2)*,. . .,*p(n)*

where each *p(n)*, if any, is a single character specifying one of the following options:

Parameter	Presence	Absence
B	Suppresses binary object	Output binary object
D	Assigns two words to integer array items and to integer and logical variables (ANSI standard)	Assigns one word to integer array items and to integer and logical variables

Parameter	Presence	Absence
H	Generate code using Floating Point Processor (FPP)	Generate no FPP instructions
L	Outputs binary object on GO file	Suppresses output of binary object on GO file
M	Suppresses symbol-table listing	Outputs symbol-table listing
N	Suppresses source listing	Outputs source listing
O	Outputs object-module listing	Suppresses object-module listing
X	Compiles conditionally	Compiles normally
F	Generates code with calls to faster firmware routines (see section 20.2)	Generates subroutine calls

The /FORT directive can contain any or all such parameters in any order.

Sample deck formats are illustrated in section 4.3.

The FORTRAN compiler reads source records from the PI logical unit. The PI unit must have been set to the beginning of device before the /FORT directive. This can be done with an /ASSIGN (section 4.2.6), /SFILE (section 4.2.7), /REW (section 4.2.10), or /PFILE (section 4.2.11) directive.

A load-and-go operation requires, in addition, an /EXEC directive (section 4.2.22)

Example: Schedule the FORTRAN compiler with binary object, source, symbol-table, and object-module listings, normal compilation; and no binary-object output on the GO file.

```
/FORT,O
```

4.2.16 /CONC (System Concordance) Directive

This directive schedules the system concordance program (section 5.2) for background operation. It has the form

/CONC,L

where L is an optional parameter to request that all symbols in a source program be listed. Normally, CONC only lists those symbols which were referenced.

The concordance program inputs from the SS logical unit and uses the same source statements that are input to the DAS MR assembler. It outputs to the LO logical unit a listing of all symbols and their referenced locations in the same input program.

The SS unit is set to the beginning of device before the /CONC directive.

Example: Schedule the system concordance program.

```
/ASSIGN,PI=MT00
/REW,PI
/DASMR
/PFILE,SS,,SS
/CONC,L
```

4.2.17 /SEDIT (Source Editor) Directive

This directive schedules the symbolic source editor (section 8) for background operation on priority level 1. It has the form

/SEDIT

Example: Schedule the symbolic source editor.

```
/SEDIT
```

4.2.18 /FMAIN (File Maintenance) Directive

This directive schedules the file maintenance task (section 9) for background operation on priority level 1. It has the form

/FMAIN

Example: Schedule the file maintenance task

```
/FMAIN
```

4.2.19 /LMGEN (Load-Module Generator) Directive

This directive schedules the load-module generator (section 6) for background operation on priority level 1. A memory map is output unless suppressed. The directive has the general form

```
        /LMGEN,M
```

where *M*, if present, suppresses the output of a memory map

Example: Schedule the load module generator task without a memory map.

```
/LMGEN,M
```

4.2.20 /IOUTIL (I/O Utility) Directive

This directive schedules the I/O utility processor (section 10) for background operation on priority level 0. The directive has the form

```
        /IOUTIL
```

Example: Schedule the I/O utility processor.

```
/IOUTIL
```

4.2.21 /SMAIN (System Maintenance) Directive

This directive schedules the system maintenance task (section 16) for background operation on priority level 1. The directive has the form

```
        /SMAIN
```

Example: Schedule the system maintenance task

```
/SMAIN
```

4.2.22 /EXEC (Execute) Directive

This directive schedules the load-module loader to load and execute a load module from the SW logical unit file. Add LMGEN and GO usage since this is not a VORTEX system task, execution is on priority level 0. The directive has the general form

```
        /EXEC,D
```

Where D, if present, dumps all of the background upon completion of execution. The dump format consists of eight memory locations per line. Both octal and ASCII representation appear in the dump. During ASCII dump non-ASCII characters appear as blanks. ASCII dump is suppressed if dump is to a TY or CT device.

The dump format consists of eight memory locations per line as follows

```
XXXXXX AAAAAA BBBBBB .. HHHHHH
```

where XXXXXX is the starting memory address location of the eight following data words and AAAAAA through HHHHHH are the octal values of those locations. The occurrence of an asterisk between two lines indicates that all dump lines between those lines have the same value as the previous line.

/EXEC can be used to create a load module (named SW) on the SW logical unit and then schedule it, or to execute an existing load module on the SW logical unit. The action taken depends on the setting of bit 2 of the low core flag V$JCPF. If the bit is set, LMGEN is scheduled to read binary from the GO logical unit and catalog the task on SW. If the bit is not set, the current load module on SW is executed. This bit is set by performing a "load and go" assembly or compulation using the "L" option flag. This bit is cleared by the loading of any background program. (**Note:** JCP directives which do not load tasks, for example, /ASSIGN, /PFILE, do not clear this bit.). The load module on SW may be executed at anytime until SW is modified (i.e., another load and go, LMGEN, COMSY, or any other task that writes to SW).

Example: Schedule the loading of a user load module from the SW unit file without a background dump.

```
/EXEC
```

Schedule a FORTRAN load and go operation.

```
/FORT,L
/EXEC
```

When a dump has been specified the dump will be output to the List Output unit after the task exits or is aborted. Once the dump has started, it may be terminated by use of the Operator Communication ;ABORT. When the dump is aborted in this manner, it is required that the executing task be aborted by a previous action.

Example:

/EXEC,D	Executes a load module from SW unit file requesting background dump on exit
;ABORT,SW	Causes the task to abort and dump the background
;ABORT,JPDUMP	Causes the background dump to be aborted
;ABORT,SW	Causes the task to be released and JCP to be reloaded

4.2.23 /LOAD Directive

This directive schedules a user task, which must be present in the background library or alternate library, for background execution on priority level 0. The directive has the general form

/**LOAD,name**,*p(1).p(2), .p(3)*

where

name is the name of the user task being scheduled

each *p(n)* (if any) is a parameter required by the user task

Each parameter specified, if any, will be in the job-control buffer when the user task is scheduled. The parameter string, which can extend to the end of the 80-character buffer, will appear in the buffer exactly as it does in the input directive. The address of the first word of the parameter string is in location V$JCB.

Example: Schedule the user task TSKONE with parameters ALPHA1 and ALPHA2.

```
/LOAD,TSKONE,ALPHA1,ALPHA2
```

4.2.24 /ALTLIB (Alternate Library) Directive

This directive replaces the background library with the specified alternate library unit as the unit from which a background task is to be loaded. The directive has the general form:

/**ALTLIB,lun,key**

where

lun is the number or name of the alternate library logical unit

key is the protection code required to address lun

This directive affects the loading of the next task which would normally be loaded from the background library. It affects the loading of VORTEX language processors and utility tasks in addition to user tasks loaded with the /LOAD directive.

It has no effect on a /EXEC directive. After execution of the background task, the background library is restored as the logical unit from which background tasks are to be loaded.

Example: Schedule the user task TSKONE from logical unit 25, protection key N.

```
/ALTLIB,25,N
/LOAD,TSKONE
```

4.2.25 /DUMP Directive

This directive causes all of background to be dumped upon completion of execution of a task executed from the background library or an alternate library. The dump format is the same as the format for /EXEC,D (see section 4.2.22).

Example: Schedule the execution of user task TSKONE with a dump at completion of execution.

```
/DUMP
/LOAD,TSKONE
```

4.2.26 /CFILE Directive

This directive, which applies only to RMDs and MTs assigned to global logical units, causes the designated file on the logical unit to be closed with update. It has the general form

/**CFILE**,lun,key,name

where

lun is the name or number of the affected logical unit. The logical unit must be one of the global logical units.

key is the protection code required to address lun

name is the name of the file on lun to be closed with update.

Example: Close the file FILEA on logical unit PO with no protection code.

```
/CFILE,PO,,FILEA
```

4.2.27 /DBGEN (Data Base Generator) Directive

This directive schedules the Data Set Generator Program (see TOTAL Manual for more detailed information) for background operation on priority level 1. It has the form

/**DBGEN**

Example: Schedule the Data Base Generator for TOTAL.

```
/DBGEN
```

4.2.28 /PLOAD Directive

This directive schedules a user task, which must be present in the background library or alternate library, for background execution on priority level 1. The directive has the general form

```
/PLOAD,xxxxxx,p(1),p(2),...p(n)
```

where

xxxxxx is the name of the user task being scheduled. The name must not contain numeric characters.

p(n) is a parameter required by the user task.

Each parameter specified, if any, will be in the job-control buffer when the user task is scheduled. The parameter string, which can be extended to the end of the 80 character buffer, will appear in the buffer exactly as it does in the input directive. The address of the first word of the parameter string is in location V$JCB.

4.2.29 /FMUTIL Directive

This directive causes files, directories, and/or partitions to be dumped or loaded from RMD's or magnetic tapes, and schedules the file maintenance utility (section 21) for background operation on priority level 1. The directive has the form

```
/FMUTIL
```

Examples: Schedule File Maintenance Utility.

```
/FMUTIL
```

4.2.30 /RPG (RPG II Compiler) Directive

This directive schedules the RPG II compiler (section 5.5) with the specified options for background operations on priority level 1. It has the general form

```
/RPG,p(1),p(2),...,p(n)
```

where

p(n) is a single character specifying one of the following options:

Parameter	Presence	Absence
B	Suppresses binary object.	Output binary object.
O	Include RPG debug features in object module.	Suppress debug features.
L	Outputs binary object on GO file.	Suppresses output of binary object on GO file.
M	Suppresses symbol table listing.	Outputs symbol table listing.
N	Suppresses source listing.	Outputs source listing.

The /RPG directive can contain up to five such parameters in any order.

Sample deck formats are illustrated in section 4.3.

The RPG II compiler reads source records from the PI logical unit. The PI unit must have been set to the beginning of device before the /RPG directive. This can be done with an /ASSIGN (section 4.2.6), /SFILE (section 4.2.7), /REW (section 4.2.10), or /PFILE (section 4.2.11) directive.

Example: Schedule the RPG II compiler with binary object, source, and symbol-table listings; normal compilation; and no binary object output on the GO file.

```
/RPG
```

Example: Schedule RPG II for normal compilation but with binary object output on the GO file instead of the BO file.

```
/RPG,L,B
```

4.2.31 /P (Pause) Directive

This directive outputs the specified comment to the SO and LO logical units and then causes JCP to be suspended. In addition to the specified comment, instructions are output to SO on how to resume JCP. It has the general form

```
/P,comment
```

where

comment is any desired free-form comment.

Example: Request that the current job requires MT = 800 on MT00 before it continues.

```
/P, Mount MT #800 on MT00
```

in addition, JCP will output:

```
  Pause---WHEN READY, TYPE --;RESUME, JCP
```

4.3 SAMPLE DECK SETUPS

The batch-processing facilities of VORTEX are invoked by JCP control directives in combination with programs and data. These elements form the input job stream to VORTEX. The input job stream can come from various peripherals and be carried on various media. These examples illustrate common job streams and deck preparation techniques.

Example 1 - Card Input: Compile a FORTRAN IV main program (with source listing and octal object listing), and assemble a DAS MR subprogram. Then load and execute the linked program.

```
/JOB,EXAMPLE1
/FORT,L,O
        .
        .
        .
  (Source Deck)
        .
/DASMR,L
        .
  (Source Deck)
        .
        .
        .
/EXEC
/ENDJOB
```

Example 2 - Card Input: Assemble a DAS MR program (with source listing and load-and-execute) and generate a concordance listing. The DAS MR program is cataloged on RMD partition D00K under file name USER1 with protection key U. Assign the PI logical unit to RMD partition D00K, open file name USER1 for the assembler, assemble the program, and execute the program with a dump.

```
/JOB,EXAMPLE2
/ASSIGN,PI=D00K
/PFILE,PI,U,USER1
/DASMR,L
/PFILE,SS,,SS
/CONC
/EXEC,D
/ENDJOB
```

Example 3 - Card Input: Assemble a DAS MR program (with source listing and object-module output on the BO logical unit). Assign the PI logical unit to magnetic-tape unit MT00, the PO logical unit to dummy device, the SS logical unit to the PI logical unit, the BO logical unit to RMD partition D00J, and output the object module to file name USER2 with no protection key. Before assembly, position the PI logical unit to the third file. Allocate four additional 512-word blocks for the DAS MR symbol-table area.

```
/JOB,EXAMPLE3
/ASSIGN,PI=MT00,PO=DUM,SS=PI,BO=D00J
/REW,PI
/SFILE,PI,2
/PFILE,BO,,USER2
/MEM,4
/DASMR
/ENDJOB
```

Example 4 - Card Input: After generation of a VORTEX system, use FMAIN to initialize and add object modules to the object-module library (OM) with protection key D. Assign the BI logical unit to CR00.

```
/JOB,EXAMPLE4
/ASSIGN,BI=CR00
/FMAIN
INIT,OM,D
INPUT,BI
ADD,OM,D
        .
        .
        .
   (Object Modules)
        .
  (2-7-8-9 EOF Card)
        .
        .
        .
/ENDJOB
```

Example 5 - Card Input: Load and go operation. Compile a FORTRAN IV main program, a subprogram and assemble a DASMR subprogram. Save output on BO. Execute the linked programs

```
/JOB,EXAMPLE5
/PFILE,BO,,BO
/FORT,L
        .
        .
        .
        (Source deck FORTRAN main program)
        .
        (Source deck FORTRAN subprogram)
        .
/DASMR,L
        .
        (Source deck DASMR subprogram)
        .
        .
        .
/EXEC
/FINI
```

SECTION 5
LANGUAGE PROCESSORS

The VORTEX operating system supports three language processors: the *DAS MR assembler* (section 5.1), the *FORTRAN IV compiler* (section 5.3), and the *RPG IV compiler* (section 5.4), plus the ancillary *concordance program* (section 5.2.).

5.1 DAS MR Assembler

DAS MR is a two-pass assembler scheduled by job-control directive /DASMR (section 4.2.14). DAS MR uses the secondary storage device unit for pass 1 output. It reads a source module from the PI logical unit and outputs it on the PO unit. The source input for pass 2 is entered from the SS logical unit.

When an END statement is encountered, the SS unit is repositioned and reread. During pass 2, the output can be directed to the BO and/or GO units for the object module and the LO unit for the assembly listing. The SS or PO file, which contains a copy of the source module, can be used as input to a subsequent assembly.

A DAS MR symbol consists of one to six characters, the first of which must be alphabetic, with the rest alphabetic or numeric. Additional alphanumeric characters can be appended to the first six characters of the symbol to form an extended symbol up to the limit imposed by a single line of code. However, only the first six characters are recognized by the assembler.

DAS MR symbols may also be formed from the pound sign, exclamation mark or dollar sign, in initial and other positions.

Since the DAS MR assembler is used within the VORTEX system under VORTEX I/O control, the VORTEX user can specify the desired I/O devices. However, the PO and SS logical units must be the same magnetic-tape unit or RMD partition. Except when PI is equal to SS as shown in section 4.3 (example 3).

DAS MR has a symbol-table area for 175 symbols at five words per symbol. To increase this area, input before the /DASMR directive a /MEM directive (section 4.2.5), where each 512-word block enlarges the capacity of the table by 100 symbols.

A VORTEX physical record on an RMD is 120 words. Source records are blocked three 40-word records per VORTEX physical record, and object modules are blocked two 60-word modules per record. However, in the case where SI = PI = RMD, records are not blocked but assumed to be one per VORTEX physical record. When an input file contains more than one source module each new source module must start at a physical record boundary. Unused portions of the last physical record of the previous source modules should be padded with blank records. Proper blocking may be ensured by following the END statement of the previous source module with two blank records.

Detailed references to the DAS MR assembly language are given in the appropriate Varian reference manuals (see section 1.3). These references include descriptions of the directives recognized by the assembler (table 5-1), except for the title directive which is discussed below. DAS MR will assemble the entire V75 extended instruction set if the E parameter is specified in the /DASMR directive.

Table 5-1. Directives Recognized by the DAS MR Assembler

```
BES      IFF
BSS      IFT
CALL     LIST
COMN     LOC
CONT     MAC
DATA     MZE
DETL     NAME
DUP      NLIS
EJEC     NULL
END      OPSY
EMAC     ORG
ENTR     PZE
EQU      RETU
EXT      SET
FORM     SPAC
GOTO     SMRY
         TITLE
```

Error messages applicable to the DAS MR assembler are given in Appendix A.5.1.

5.1.1 TITLE Directive

This directive changes the title of the assembly listing and the identification of the object program. It has the general form

```
TITLE     symbol
```

where *symbol* is the new title of the assembly listing, the label field being ignored by the assembler. There are a maximum of eight characters in *symbol*.

At the beginning of assembler pass 1, the title of the assembly listing and the identification of the object program are initialized as blanks. When a TITLE directive is encountered, title and identification assume the *symbol* given in the directive.

Examples: Entitle the assembly listing and object program NEWTITLE.

```
TITLE     NEWTITLE
```

Reinitialize the title and identification, obliterating the old title.

```
TITLE
```

5.1.2 VORTEX Macros

The DAS MR assembler contains macro definitions for the real-time executive (RTE, section 2.1) and I/O control (IOC, section 3.5) macros. Figure 5-1 illustrates these definitions.

```
*
M1          MAC
            EXT         V$IOC
            JSR         0404,1
            DATA        0100000
F           FORM        1,3,4,8
            F           P(1),P(2),P(3),P(4)
            DATA        P(5),0,0
            EMAC
*
*           VORTEX READ MACRO DEFINITION
*           READ        DCB,LUN,W,M
*                             WHERE DCB = FCB OR DCB ADDRESS
*                                   LUN = LOGICAL UNIT NO.
*                                     W = WAIT OPTION
*                                     M = I/O MODE
READ        MAC
            M1          P(3),P(4),0,P(2),P(1)
            EMAC
*
*           VORTEX WRITE MACRO DEFINITION
*           WRITE       DCB,LUN,W,M
*                             WHERE DCB = FCB OR DCB ADDRESS
*                                   LUN = LOGICAL UNIT NO.
*                                     W = WAIT OPTION
*                                     M = I/O MODE
WRITE       MAC
            M1          P(3),P(4),1,P(2),P(1)
            EMAC
*
*           VORTEX WRITE END OF FILE MACRO DEFINITION
*           WEOF        DCB,LUN,W
*                             WHERE DCB = FCB OR DCB ADDRESS
*                                   LUN = LOGICAL UNIT NO.
*                                     W = WAIT OPTION
WEOF        MAC
            M1          P(3),0,2,P(2),P(1)
            EMAC
*
*           VORTEX REWIND MACRO DEFINITION
*           REW         DCB,LUN,W
*                             WHERE DCB = FCB OR DCB ADDRESS
*                                   LUN = LOGICAL UNIT NO.
*                                     W = WAIT OPTION
REW         MAC
            M1          P(3),0,3,P(2),P(1)
            EMAC
*
*           VORTEX SKIP RECORD MACRO DEFINITION
*           SREC        DCB,LUN,W,M
*                             WHERE DCB = FCB OR DCB ADDRESS
*                                   LUN = LOGICAL UNIT NO.
*                                     W = WAIT OPTION
*                                     M = I/O MODE
```

Figure 5-1. VORTEX Macro Definitions for DAS MR

```
SREC      MAC
          M1        P(3),P(4),4,P(2),P(1)
          EMAC
*
*         VORTEX FUNCTION MACRO DEFINITION
*         FUNC      DCB,LUN,W
*                        WHERE DCB = FCB OR DCB ADDRESS
*                              LUN = LOGICAL UNIT NO.
*                                W = WAIT OPTION
FUNC      MAC
          M1        P(3),0,5,P(2),P(1)
          EMAC
*
*         VORTEX OPEN MACRO DEFINITION
*         OPEN      FCB,LUN,W,M
*                        WHERE FCB = FCB OR DCB ADDRESS
*                              LUN = LOGICAL UNIT NO.
*                                W = WAIT OPTION
*                                M = I/O MODE
OPEN      MAC
          M1        P(3),P(4),6,P(2),P(1)
          EMAC
*
*         VORTEX CLOSE MACRO DEFINITION
*         CLOSE     FCB,LUN,W,M
*                        WHERE FCB = FCB OR DCB ADDRESS
*                              LUN = LOGICAL UNIT NO.
*                                W = WAIT OPTION
*                                M = I/O MODE
CLOSE     MAC
          M1        P(3),P(4),7,P(2),P(1)
          EMAC
*
*         VORTEX STATUS MACRO DEFINITION
*         STAT      FCB,ERR,EOF,EOD,BUSY
*                        WHERE FCB = FCB OR DCB ADDRESS
*                              ERR = ERROR RETURN ADDRESS
*                              EOF = END OF FILE, BEGINNING
*                                      OF DEVICE, OR BEGINNING OF
*                                      TAPE RETURN ADDRESS
*                              EOD = END OF DEVICE OR END OF TAPE
*                                      RETURN ADDRESS
*                             BUSY = BUSY RETURN ADDRESS
*
STAT      MAC
          EXT       V$IOST
          JSR       0373,1
          DATA      P(1),P(2),P(3),P(4),P(5)
          EMAC
*
*         VORTEX DEVICE CONTROL BLOCK MACRO DEFINITION
*         DCB       RL,BUF,CNT
*                        WHERE RL = RECORD LENGTH
*                             BUF = DATA ADDRESS
*                             CNT = COUNT
DCB       MAC
          DATA      P(1),P(2),P(3)
          EMAC
```

Figure 5-1. VORTEX Macro Definitions for DAS MR *(continued)*

```
*         VORTEX FILE CONTROL BLOCK MACRO DEFINITION
*         FCB       RL,BUF,AC,KEY,'N1','N2','N3'
*                        WHERE RL = RECORD LENGTH
*                             BUF = DATA ADDRESS
*                             AC = ACCESS METHOD
*                             KEY = PROTECTION KEY
*                             N1 = FIRST 2 ASCII FILE NAME
*                             N2 = SECOND 2 ASCII FILE NAME
*                             N3 = THIRD 2 ASCII FILE NAME
FCB       MAC
          DATA      P(1),P(2)
F         FORM      6,2,8
          F         0,P(3),P(4)
          DATA      0,0,0,0,P(5),P(6),P(7)
          EMAC
*
M2        MAC
          EXT       V$EXEC
          JSR       0406,1
          EMAC
*
*         VORTEX SCHEDULE MACRO DEFINITION
*         SCHED     PL,W,LUN,KEY,'N1','N2','N3'
*                        WHERE PL = PRIORITY LEVEL
*                             W = WAIT OPTION
*                             LUN = LOGICAL UNIT NO.
*                             KEY = PROTECTION KEY
*                             N1 = FIRST 2 ASCII TASK NAME
*                             N2 = SECOND 2 ASCII TASK NAME
*                             N3 = THIRD 2 ASCII TASK NAME
SCHED     MAC
          M2
F         FORM      3,1,6,1,5
          F         0,P(2),1,0,P(1)
F         FORM      8,8
          F         P(4),P(3)
          DATA      P(5),P(6),P(7)
          EMAC
*
*         VORTEX EXIT MACRO DEFINITION
*         EXIT
*
EXIT      MAC
          M2
          DATA      0200
          EMAC
*
*         VORTEX SUSPEND MACRO DEFINITION
*         SUSPND    T
*                        WHERE T = TYPE OF SUSPENSION
SUSPND    MAC
          M2
F         FORM      4,6,5,1
          F         0,3,0,P(1)
          EMAC
*
*         VORTEX RESUME MACRO DEFINITION
*         RESUME    'N1','N2','N3'
*                        WHERE N1 = FIRST 2 ASCII TASK NAME
*                              N2 = SECOND 2 ASCII TASK NAME
*                              N3 = THIRD 2 ASCII TASK NAME
```

Figure 5-1. VORTEX Macro Definitions for DAS MR *(continued)*

```
RESUME    MAC
          M2
          DATA      0400,P(1),P(2),P(3)
          EMAC
*
*         VORTEX ABORT MACRO DEFINITION
*         ABORT     'N1','N2','N3'
*                        WHERE N1 = FIRST 2 ASCII TASK NAME
*                              N2 = SECOND 2 ASCII TASK NAME
*                              N3 = THIRD 2 ASCII TASK NAME
ABORT     MAC
          M2
          DATA      0500,P(1),P(2),P(3)
          EMAC
*
*         VORTEX ALLOCATE MACRO DEFINITION
*         ALOC      ADDR
*                        WHERE ADDR = ADDRESS OF REENTRANT
*                                     SUBROUTINE
ALOC      MAC
          M2
          DATA      0600,P(1)
          EMAC
*
*         VORTEX DEALLOCATE MACRO DEFINITION
*         DEALOC
*
DEALOC    MAC
          M2
          DATA      0700
          EMAC
*
*         VORTEX PRIORITY INTERRUPT MASK MACRO DEFINITION
*         PMSK      NUM,MSK,TYP
*                        WHERE NUM = PIM NUMBER
*                              MSK = PIM LINE MASK
*                              TYP = ENABLE OR DISABLE TYPE
PMSK      MAC
          M2
F1        FORM      4,6,5,1
          F1        0,010,0,P(3)
F         FORM      8,8
          F         P(1),P(2)
          EMAC


*
*         VORTEX DELAY MACRO DEFINITION
*         DELAY     T5,TM,DT
*                        WHERE T5 = DELAY TIME IN 5 MILLI-
*                                   SECOND INCREMENTS
*                              TM = DELAY TIME IN 1 MINUTE
*                                   INCREMENTS
*                              DT = DELAY TYPE
DELAY     MAC
          M2
F         FORM      4,6,4,2
          F         0,011,0,P(3)
          DATA      P(1),P(2)
          EMAC
```

Figure 5-1. VORTEX Macro Definitions for DAS MR *(continued)*

```
*
*         VORTEX LDELAY MACRO DEFINITION
*         LDELAY    T5, TM, LUN,KEY
*                        WHERE T5 = DELAY TIME IN 5-MILLISECOND
*                                     INCREMENTS
*                              TM = DELAY TIME IN 1-MINUTE
*                                     INCREMENTS
*                             LUN = LOGICAL UNIT NUMBER FOR TASK LOAD
*                             KEY = PROTECTION KEY
LDELAY     MAC
           M2
           DATA      01107,P(1),P(2)
           FORM      8,8
           F         P(4),P(3)
           EMAC
*
*         VORTEX TIME REQUEST MACRO DEFINITION
*         TIME
*
TIME      MAC
          M2
          DATA      01200
          EMAC
*
*         VORTEX OVERLAY MACRO DEFINITION
*         OVLAY     TF,'N1','N2','N3'
*                        WHERE TF = TYPE FLAG
*                              N1 = FIRST 2 ASCII TASK NAME
*                              N2 = SECOND 2 ASCII TASK NAME
*                              N3 = THIRD 2 ASCII TASK NAME
*
OVLAY     MAC
          M2
F         FORM      4,6,5,1
          F         0,013,0,P(1)
          DATA      P(2),P(3),P(4)
          EMAC
*
*         VORTEX IOLINK MACRO DEFINITION
*         IOLINK    LUN,BUF,NUM
*                        WHERE LUN = LOGICAL UNIT NO.
*                              BUF = USER'S BUFFER LOCATION
*                              NUM = BUFFER SIZE
IOLINK    MAC
          M2
F         FORM      4,6,6
          F         0,014,P(1)
          DATA      P(2),P(3)
          EMAC
*
*
*         VORTEX PASS MACRO DEFINITION
*         PASS           COUNT,FROM,TO
*                             WHERE COUNT = WORD COUNT
*                                   FROM  = FROM ADDRESS
*                                   TO    = TO ADDRESS
*
```

Figure 5-1. VORTEX Macro Definitions for DAS MR *(continued)*

```
*
PASS      MAC
          M2
F         FROM          4,6,6
          F             0,016,0
          DATA          P(1),P(2),P(3)
          EMAC
*
*         VORTEX TBEVNT MACRO DEFINITION
*         TBEVNT     VALUE, x DISP, x C/S

*
*         WHERE
                     VALUE = IS A BIT MASK

                     DISP  = IS THE TIDB WORD TO BE ALTERED.
                             IT IS EXPRESSED BY WAY OF A NUMBER,
                             THE DISPLACEMENT (OR POSITION) OF THIS
                             WORD IN THE TIDB.

                     C/S   = IS THE CLEAR/SET INDICATION (0 = CLEAR,
                             1 = SET)

          OPTIONS:           BOTH DISP AND C/S ARE OPTIONAL AND
                             THE DEFAULT FOR BOTH IS 0.

          IMPLEMENTATION:
                             WHEN DISP = 0 THE ACTION DEPENDS ON
                             THE VALUE OF VALUE:

*                            VALUE, IF 0-177776, IS SET INTO
*                            THE REQUESTING TASK'S TIDB TBEVNT
*                            WORD.  IF VALUE IS 0177777, RETURN
*                            IS WITH THE REQUESTOR'S TBEVNT IN
*                            THE A REGISTER

                             WHEN DISP = 0, DISP WILL BE ALTERED
                             ACCORDING TO VALUE AND C/S.

                             C/S = 0,  ALL THE BITS IN DISP CORRESPONDING
                                       TO THE ZERO (0) BITS IN VALUE
                                       WILL BE RESET TO 0.

                             C/S = 1,  ALL THE BITS IN DISP CORRESPONDING
                                       TO THE ONE (1) BITS IN VALUE OR
                                       WILL BE SET TO 1.

TBEVNT    MAC
          M2
          DATA          01700
          DATA          P(1),P(2),P(3)
          EMAC
*
```

Figure 5-1. VORTEX Macro Definitions for DAS MR *(continued)*

```
*         VORTEX ALLOCATE PAGE MACRO DEFINITION
*         ALOCPG         N,LOGICA  ADDR,REJECT ADDR
*                                  WHERE N = NUMBER OF PAGES TO ALLOCATE
*                             LOGICAL ADDR = LOGICAL ADDRESS
*                                            MODULO 01000, WHERE
*                                            PAGES ARE ALLOCATED
*                             REJECT ADDR  = ERROR RETURN ADDRESS
*
ALOCPG    MAC
          M2
          DATA           02000
          DATA           P(1)
          DATA           P(2)
          DATA           P(3)
          EMAC
*
*         VORTEX DEALLOCATE PAGE MACRO DEFINITION
*         DEALPG         N,LOGICAL ADDR,REJECT ADDR
*                                  WHERE N = NUMBER OF PAGES TO DEALLOCATE
*                             LOGICAL ADDR = LOGICAL ADDRESS,
*                                            MODULO 01000, WHERE
*                                            PAGES ARE TO BE
*                                            DEALLOCATED
*                             REJECT ADDR  = ERROR RETURN ADDRESS
*
*
DEALPG    MAC
          M2
          DATA           02100
          DATA           P(1)
          DATA           P(2)
          DATA           P(3)
          EMAC
*
*         VORTEX MAPIN MACRO DEFINITION
*         MAPIN          N,LOBICAL ADDR,BUFFER ADDR,REJECT ADDR
*                                  WHERE N = NUMBER OF PAGES TO BE MAPPD
*                             LOGICAL ADDR = LOGICAL ADDRESS, MODULO
*                                            01000, WHERE PAGES ARE TO
*                                            BE ALLOCATED
*                             BUFFER ADDR  = PHYSICAL PAGE NUMBER
*                                            OR BUFFER ADDRESS CON-
*                                            TAINING PHYSICAL PAGES
*                                            TO BE MAPPED
*                             REJECT ADDR  = ERROR RETURN ADDRESS
*
*
MAPIN     MAC
          M2
          DATA           02200
          DATA           P(1)
          DATA           P(2)
          DATA           P(3)
          DATA           P(4)
          EMAC
```

Figure 5-1. VORTEX Macro Definitions for DAS MR *(continued)*

```
*         VORTEX PAGE NUMBER MACRO DEFINITION
*         PAGNUM    LOGICAL ADDR
*                            WHERE LOGICAL ADDR = ADDRESS WITHIN THE
*                                                 REQUESTING TASK'S VIRTUAL
*                                                 MEMORY WHERE IDENTIFICATION
*                                                 OF THE ASSIGNED PHYSICAL
*                                                 PAGE IS REQUIRED
*
*
PAGNUM    MAC
          M2
          DATA          02300
          DATA          P(1)
          EMAC
```

Figure 5-1. VORTEX Macro Definitions for DAS MR (continued)

5.1.3 Assembly Listing Format

Figure 5-2 is a sample listing following the format described in this section.

Page format: The assembly listing is limited to the number of lines per page specified by the VORTEX resident constant V$PLCT, with each line containing no more than 120 characters. Each page has a page number and title line followed by one blank line, and then the program listing containing two lines less than the number specified by V$PLCT. (This specification can be changed through the job-control processor (JCP).)

```
PAGE    23    01/22/72  PROG1      VORTEX    DASMR          V$JCP

                    588            EJEC
                    589  *
                    590  *         SUBROUTINE PRINTS JCP DIRECTIVE ON SO AND LO DEVICE
                    591  *
000660 074056 A     592  JCPRT     STX       JSPRX
000661 064056 A     593            STB       JCPRB
000662 010412 A     594            LDA       V$JCB          GET BUFFER ADDRESS
000663 005311 A     595            DAR
000664 054003 A     596            STA       *+4            SETUP LOFCB
                    597            IOLINK    LO,*,41
000665 006505 A
000666 000604 E
000667 001405 A
000670 000665 R
000671 000051 A
000672 030400 A     598            LDX       V$LUT1         ADRS OF LOG UNIT TBL
000673 015003 A     599            LDA       SO,X
000674 150463 A     600            ANA       BM377          SO CUR ASSIGNMT
000675 054274 A     601            STA       JCTA
000676 015002 A     602            LDA       SI,X
000677 150463 A     603            ANA       BM377          SO CUR ASSIGNMT
000700 144271 A     604            SUB       JCTA           SO, SI SAME LUN
000701 001010 A     605            JAZ       JCPR1
000702 000714 R
000703 017000 I     606            LDA       JCFBCS+3       STORE 'LOFCB' ADRS IN CALL
000704 054004 A     607            STA       *+5
                    608            WRITE     LOFCB,SO,0,1   NO - WRITE TO SO
000705 006505 A
000706 000630 E
000707 100000 A
000710 010403 A
000711 000633 E
000712 000000 A
000713 000000 A
000714 030400 A     609  JCPR1     LDX       V$LUT1
000715 015005 A     610            LDA       LO,X
000716 150463 A     611            ANA       BM377          LO CUR ASSIGNMT
000717 144252 A     612            SUB       JCTA           LO, SO SAME LUN
000720 001010 A     613            JAZ       JCPRE          YES
000721 000733 R
000722 017000 A     614            LDA       JCFCBS+3       STORE 'LOFCB' ADRS IN CALL
000723 054004 A     615            STA       *+5
                    616            WRITE     LOFCB,LO,0,1   NO - WRITE TO LO
```

Figure 5-2. Sample Assembly Listing

At the end of the assembly, the following information is printed after the END statement:

a. A line containing the subheading ENTRY NAMES

b. All entry names (in four columns), each preceded by its value and a flag to denote whether the symbol is absolute (A), relocatable (R), or common (C).

c. A line containing the subheading EXTERNAL NAMES

d. All external names (in four columns), each preceded by its value and a flag to denote that the symbol is external (E)

e. A line containing the subheading SYMBOL TABLE

f. The symbol table (in four columns), each symbol preceded by its value and a flag to denote whether the symbol is absolute (A), relocatable (R), common (C), or external (E)

g. A line containing the subheading mmmm ERRORS ASSEMBLY COMPLETE, where mmmm is the accumulated error count expressed as a decimal integer, right-justified and left-blank-filled

Line format: Beginning with the first character position, the format for a title line is:

a. One blank

b. The word PAGE

c. One blank

d. Four character positions that contain the decimal page number

e. Two blanks

f. Eight character positions that contain the current date obtained from the VORTEX resident constant V$DATE

g. Two blanks

h. Eight character positions that contain the program identification obtained from the VORTEX resident constant V$JNAM

i. Two blanks

j. The word VORTEX

k. Two blanks

l. The word DASMR

m. Two blanks

n. Eight character positions that contain the program title from the TITLE directive

o. Blanks through the 120th character position

Beginning with the first character position, the format for an assembly line is:

a. One blank

b. Six character positions to display the location counter (octal) of the generated data word

c. One blank

d. Six character positions to display the generated data word (octal)

e. One blank

f. One character position to denote the type of generated data word: absolute (A), relocatable (R), common (C), external (E), literal (L), or indirect-address pointer generated by the assembler (I)

g. One blank

h. Four character positions containing the decimal symbolic source statement line number, right-justified and left-blank-filled

i. One blank

j. Eighty character positions that contain the image of the symbolic source statement. (If the symbolic source statement is not a comment statement, the label, operation, and variable fields are reformatted into symblolic source statement character positions 1, 8, and 16, respectively. If commas separate the label, operation, and variable fields, they are replaced by blank characters.)

k. Blanks, if necessary, through the 120th character position

Error Chaining: If syntax errors occur during an assembly error, chaining is provided to assist in finding the errors. If errors occur, the error message at the end of the assembly contains a decimal value within parentheses corresponding to the source line number at which the last error occurred. The line number referenced in turn references the next line number containing an error. The last line number containing an error does not have a chaining reference. If no errors occurred, the error message does not contain a chaining reference.

5.2 CONCORDANCE PROGRAM

The background concordance program (CONC) provides an indexed listing of all source statement symbols, giving the number of the statement associated with each symbol and the numbers of all statements containing a reference to the symbol. CONC is scheduled by job-control directive /CONC (section 4.2.16). Upon completion of the concordance listing, control returns to the JCP via EXIT.

Input to CONC is through the SS logical unit. The concordance is output on the LO unit. CONC uses system global file control block SSFCB. If the SS logical unit is an RMD, a /REW or /PFILE directive (section 10) establishes the FCB before the /CONC directive is input to the JCP.

CONC has a symbol-table area to process 400 no-reference symbols at five words per symbol, plus 400 referenced symbols (averaging five references per symbol) at ten words per symbol. To increase this area, input before the /CONC directive a /MEM directive (section 4.2.5), where each 512-word block enlarges the capacity of the table by approximately 75 symbols.

CONC processes both packed records (three source statements per 120-word VORTEX physical record) and unpacked records (one source statement per record).

5.2.1 Input

CONC receives source-statment input from the SS logical unit. There is, however, no positioning of the SS unit prior to reading the first record. The source statements are identical with those input to the VORTEX assembler and thus conform to the assembler syntax rules.

As the inputs are read, each source statement is assigned a line number, 1, 2, etc., which is identical with that printed on the assembly listing. When a symbol appears in the label field of a symbolic source statement, the line number of that source statement is assigned to the symbol. When the symbol appears in the variable field of a source statement, the line number of that statement is used as a reference for the symbol.

5.2.2 Output

CONC outputs the concordance listing on the LO logical unit. Output begins when one of the following events occurs:

a. CONC processes the source statement END

b. Another job-control directive is input

c. An SS end of file or end of device is found

d. A reading error is found

e. *The symbol-table area is filled*

If the output occurred because the symbol-table area of memory was full, CONC clears the concordance tables, outputs error message CN01, and continues until one of the other terminating conditions is encountered. In all other cases, CONC terminates by calling EXIT.

The concordance listing is made in the order of the ASCII values of the characters comprising the symbols.

Beginning with the first character position, the format for a title line is:

a. One blank

b. The word PAGE

c. One blank

d. Four character positions that contain the decimal page number

e. Two blanks

f. Eight character positions that contain the date obtained from the VORTEX resident constant V$DATE

g. Two blanks

h. Eight character positions that contain the program identification obtained from the VORTEX resident constant V$JNAM

i. Two blanks

j. The word VORTEX

k. Two blanks

l. The word CONC

m. Blanks through the 72nd character position

Beginning with the first character position, the format for a concordance cross-reference listing is:

a. Two blanks

b. Four character positions that contain the decimal line number of the source statement assigned to the symbol in item (e) below

c. One blank

d. One character position containing an asterisk (*) if there are no references to that symbol (otherwise blank)

e. Six character positions containing the symbol being listed

f. Two blanks

g. Four character positions that contain the decimal line number of a source statement referencing the symbol in item (e) above

h. Items (f) and (g) are repeated as necessary for each source statement referencing the symbol in item (e) above, where up to nine references are placed on the first line, and subsequent references on the next line(s). Continuation lines that may be required for ten or more references to the same symbol do not repeat items (a) through (e)

i. Blanks through the 72nd character position of the last line of the entry

Figure 5-3 illustrates the concordance listing.

```
PAGE    1  09/22/71     V$OPCM  VORTEX  CONC

 509  B         841   859   879   990  1001  1002  1012  1068  1072
               1074  1112  1230  1231
 261  B10      *
 262  B11      *
 263  B12      *
1206  ODATE    1180  1182  1190
1937  ONUM      895   928   936  1017  1182  1190  1196  1254  1284
               1406  1418
```

Figure 5-3. Sample Concordance Listing

5.3 FORTRAN IV COMPILER

The **FORTRAN IV compiler** is a one-pass compiler scheduled by job-control directive /FORT (section 4.2.15). The compiler inputs a source module from the PI logical unit and produces an object module on the BO and/or GO units and a source listing on the LO unit. No secondary storage is required for a compilation.

If a fatal error is detected, the compiler automatically terminates output to the BO and GO units. LO unit output continues. The compiler reads from the PI unit until an END statement is encountered or a control directive is read. Compilation also terminates on detection of an I/O error or an end-of-device, beginning-of-device, or end-of-file indication from I/O control.

The output comprises relocatable object modules under all circumstances: main programs and subroutines, function, and block-data subprograms.

Error messages applicable to the FORTRAN IV compiler are given in Appendix A.5.2.

FORTRAN IV has conditional compilation facilities implemented by an X in column 1 of a source statement. When the X appears in the /FORT directive, all source statements with an X in column 1 are compiled (the X appears on the LO listing as a blank). When the X is not present, all conditional statements are ignored by the compiler. X lines are assigned listing numbers in either case, but the source statement is printed only when the X is present.

FORTRAN IV has a symbol-table area for approximately 70 symbols (i.e., names), if none of the logical units used is assigned to an RMD device. Each RMD assignment requires buffer space of 120 words (except when BO = GO = RMD, in which case BO and GO use the same buffer) and the symbol capacity is reduced by 24 symbols per buffer. To increase the symbol-table area, input before the /FORT directive a /MEM directive (section 4.2.5), where each 512-word block enlarges the capacity of the table by 100 symbols. If a larger symbol-table is used, greater subexpression optimization is possible.

A VORTEX physical record on an RMD is 120 words. Source records are blocked three 40-word records per VORTEX physical record, object modules are blocked two 60-word modules per record, and list modules are output one record per physical record. However, in the case where SI = PI = RMD, records are not blocked but assumed to be one per VORTEX physical record. When the file contains more than one source module, each new source module must start at a physical record boundary. The unused portion of the last physical record of the previous module should be padded with blanks.

Table 5-2 lists the VORTEX real-time executive (RTE) service request macros available through FORTRAN IV. These macros are detailed in section 2.1.

Table 5-2. RTE Macros Available Through FORTRAN IV

ABORT	EXIT	SCHED
ALOC	OVLAY	SUSPND
DELAY	PMSK	TIME
LDELAY	RESUME	PASS

5.3.1 FORTRAN IV Enhancements

The VORTEX FORTRAN IV language additions and enhancements make the VORTEX FORTRAN compiler more consistent with IBM FORTRAN (level G). Except for these additions and enhancements, FORTRAN compilation and execution with the VORTEX operating system is the same as with the Master Operating System (MOS) described in the FORTRAN IV Reference Manual (98 A 9902 03x).

FORTRAN-complied programs can execute in either foreground or background.

Detailed information on the VORTEX FORTRAN IV language additions and enhancements are given in the VORTEX FORTRAN IV Reference Manual (98 A 9902 04x).

5.3.1.1 Variables

VORTEX FORTRAN IV variables are identifiers which consist of a string of one to six alphanumeric characters and correspond to the type of data the variable represents. Variables are classified into the following five fundamental types: INTEGER, REAL, DOUBLE PRECISION, COMPLEX, and LOGICAL.

The following list shows each variable type with its associated standard and optional length (in bytes):

Variable Type	Standard	Optional
INTEGER	2	4
REAL	4	8
COMPLEX	8	·
LOGICAL	2	·
DOUBLE PRECISION	8	·

5.3.1.2 Constants

There are four categories of VORTEX FORTRAN IV constants: NUMERICAL, LOGICAL LITERAL, and HEXADECIMAL. These four constant data constructions are discussed below.

NUMERICAL constants are integer, real, or complex numbers. Integer constants may be positive, zero, or negative. If the constant has so sign, it is interpreted as representing a positive value. If a zero is specified, with or without a preceding sign, the sign will have no effect on the value zero. The constant has the general form

sn

where

s is the optional signed character (+ or -).

n is a decimal character string (maximum magnitude is 1073741823).

LOGICAL constants allow for the use of logical operations through the medium of the logical expression. Thus, two logical constants are provided to represent the "true" and "false" logical values. The constant has the general form

.TRUE. or **.FALSE.**

LITERAL constants are a string of alphanumeric and/or special characters. If apsostrophes delimit the literal, a single apostrophe within the literal is represented by two apostrophes. The number of characters in a string, including blanks, may not be less than 1 or greater than 255. Blanks within the character string will be considéred part of the string. The constant has the general form

wHs or 's'

where

w is a positive non-zero constant denoting the width of the character string.

s denotes the character string.

HEXADECIMAL constant consists of the letter Z followed by 1 to 16 hexadecimal digits. The constant has the general form

Zn

where

n is a 1 to 16 hexadecimal digit string.

The maximum number of digits allowed in a hexadecimal constant depends on the length specification of the variable being initialized. If the number of digits is greater than the maximum, the left-most digits are truncated. If the number is less than the maximum, the left-most positions are filled with zeros.

5.3.1.3 IMPLICIT Statement

The IMPLICIT statement must be the first statement in a main program or the second statement in a subprogram. The statement enables the user to specify the type, including length of all variables, arrays, and function names. The statement has the general form

IMPLICIT type *s(a1,...,)

where

type is a type name.

*s is optional; and, represents one of the permissible length specifications (see variable).

a is an initial character string (A, B,...,Z,$,) in that order.

5.3.1.4 Explicit Type Statements

The Explicit Type Specification statement declares the type of variable, function name, statement function name, or array by its name rather than by its initial character. Optionally, it may also initialize the variable. The statement overrides the IMPLICIT statement, which in turn overrides the predefined convention. The statement has the general form

type**s* al*sl(*k1*)/*x1*/,...

where

type is a type name.

*s is optional; and, represents one of the permissible length specifications.

a is a variable, array, or function name.

(*k*) is optional; and, gives dimension information for arrays. When the TYPE statement in which it appears is in a subprogram, *k* may contain integer variables of length 2 (section 5.3.1.1), provided that the array is a dummy argument.

/x/ is optional; and, represents initial data values (see DATA statement).

5.3.1.5 DOUBLE PRECISION Statement

The DOUBLE PRECISION statement overrides any specification of a variable made by either the predefined convention or the IMPLICIT statement. The statement has the general form

DOUBLE PRECISION a*(k)*,...,

where

a represents a variable, array, or function name.

(k) is optional; and, is composed of one to seven unsigned integer constants that represent the maximum value of each subscript in the array. *k* may contain integer variables of length 2, provided that the array is a dummy argument.

5.3.1.6 PAUSE Statement

The execution of the PAUSE statement causes the unconditional suspension (SUSPND) of the object program being executed pending operator action. To resume the suspended task, input the operator-communication key-in request RESUME. The statement has the general form

PAUSE
or
PAUSE *n* or **PAUSE** *m*

where

n is a string of one to five decimal digits.

m is a literal constant enclosed in apostrophes.

5.3.1.7 STOP Statement

The execution of the STOP statement causes the unconditional termination of the execution of the object program beging executed. The statement has the general form

STOP
or
STOP *n* or **STOP** *m*

where

n is a string of one to five decimal digits.

m is a literal constant enclosed in apostrophes.

5.3.1.8 CALL Statement

The execution of the CALL statement causes the specified subroutine to be executed. The CALL statement arguments must agree in number and order of appearance with the dummy arguments in the SUBROUTINE statement. The statement has the general form

CALL name (a1,a2),...,

where

name is the name of a SUBROUTINE subprogram.

a is an actual argument that is being supplied to the SUBROUTINE subprogram. The argument may be a variable array element, array name, literal, or arithmetic or logical expression. Each a may also be of the form *n*, where *n* is a statement number.

5.3.1.9 RETURN Statement

The RETURN statement provides the method by which the calling program is reentered following the execution of a subprogram. The normal sequence of execution following the RETURN statement of a SUBROUTINE subprogram is to the next statement following the CALL statement in the calling program. The statement has the general form

RETURN or **RETURN** *i*

where

i is an integer constant or variable whose value, for example n, denotes the n-th asterisk in the argument list of a SUBROUTINE statement. RETURN *i* may be specified only in a SUBROUTINE subprogram.

5.3.1.10 READ/WRITE Statements

VORTEX FORTRAN IV allows two optional parameters to the READ/WRITE statements. These optional parameters allow for conditional exits on an end-of-data or transmission error.

Example: READ(4,10,ERR = 105,END = 200)A,B

In the above example, control will be transferred to statement 105 if an I/O error occurs, or to statement 200 if an end-of-data occurs on unit 4.

5.3.1.11 ENCODE/DECODE Statement

ENCODE/DECODE statements perform data conversion according to a FORMAT statement without performing external I/O operations. ENCODE statement takes an I/O list, converts each element and places it in a specified buffer. DECODE statement words from the buffer into the I/O list. For example:

```
      DIMENSION I(40)
      READ(CDR,10)I
   10 FORMAT(40A2)
      DECODE(10,20,I)K,L
   20 FORMAT(2I5)
```

These statements read an ASCII card image into array I. The first two fields of five ASCII characters are then decoded into their integer equivalent and placed into the variables K and L.

5.3.1.12 Direct-Access INPUT/OUTPUT Statements

The direct-access INPUT/OUTPUT statements allows a programmer to go directly to any point in a file which resides on an RMD, and process a record without having to process all the records within the file. To use direct-access INPUT/OUTPUT statements (READ, WRITE, and FIND), the file(s) to be operated on must be described with a DEFINE FILE statement. The statement has the general form

DEFINE FILE a1(m1,r1,f1,v1),...

where

a specifies the unit number.

m represents the relative position of a record within the file.

r specifies the maximum size of each record in the file.

f specifies whether the file is to be read or written with or without format control.

v specifies an integer variable (not an array element) called an associated variable, which points to the record immediately following the last record transmitted.

5.3.1.13 Direct-Access READ Statement

The READ statement causes data to be transferred from a direct-access device into internal storage. The statement has the general form

READ(a'r,*b*,*ERR* = εc)*list*

where

a specifies the unit number and must be followed by an apostrophe.

r represents the relative position of a record within the file.

b is optional; and, if given, is either the statement number of the FORMAT statement, or the name of an array that contains an object-time format.

ERR = εc is optional; and, specifies the number of a statement to which control is given when an error condition is encountered

list is optional; and, is an I/O list. The I/O list must not contain the associated variable.

5.3.1.14 Direct-Access WRITE Statement

The WRITE statement causes data to be transferred from internal storage to a direct-access device. The statement has the general form

WRITE (a'r,*b*)*list*

where

a specifies the unit number and must be followed by an apostrophe

r represents the relative position of a record within the file.

b is optional; and, if given, is either the statement number of the FORMAT statement, or the name of an array that contains an object-time format.

list is optional; and, is an I/O list. The list must not contain the associated variable.

5.3.1.15 FIND Statement

The FIND statement causes the next input record to be found while the present record is being processed. The statement has the general form

FIND (a'r)

where

a specifies the unit number and must be followed by an apostrophe.

r represents the relative position of a record within the file.

At the conclustion of a FIND operation, the associated variable points to the record found.

5.3.1.16 DATA Statement

The DATA statement is used to define initial values of variables, array elements, and arrays. This statement cannot precede any specification statement that refers to the same variables, array elements, or arrays. The DATA statement may not precede an IMPLICIT statement. It has the general form

DATA k/d/,...

where

k is a list containing variables, array elements. or array names.

d is a list of constants (integer, real, complex, hexadecimal, logical, or literal), any of which may be preceded by *i**, where *i** indicates that the constant is to be specified i times.

5.3.1.17 TITLE Statement

The TITLE statement declares a module name which is output to the top of each page of the source listing and to the object module. It has the general form

TITLE name

where

name is the title to be output. The title contains up to eight characters, and is output in the object text * as the name by which the program is to be referenced by SMAIN.

If a TITLE statement is used, it must be the first source statement. A TITLE statement forces a page eject on the LO listing.

5.3.1.18 Subprogram Multiple Entry

VORTEX FORTRAN IV facilitiates multiple entry into SUBROUTINE and FUNCTION subprograms by specifying a CALL statement or a FUNCTION reference that refers to an ENTRY statement in the subprogram. Entry is made at the first executable statement following the ENTRY statement. The statement has the general form

ENTRY name(a1,a2,a3),...

where

name is the name of an entry point

a is a dummy argument corresponding to an actual argument in a CALL statement or FUNCTION reference

5.3.1.19 SUBROUTINE Subprogram

The SUBROUTINE subprogram may contain any FORTRAN IV statement except a FUNCTION statement, another SUBROUTINE statement, or an BLOCK DATA statement. If an IMPLICIT statement is specified, it must immediately follow the SUBROUTINE statement. SUBROUTINE has the general form

SUBROUTINE name(a1,a2,a3),...

where

name is the SUBROUTINE name.

a is a distinct dummy argument. Each argument used must be a variable or array name, the dummy name of another SUBROUTINE, FUNCTION subprogram, or an asterisk "*" which denotes a return point specified by a statement number in the calling program.

The actual arguments can be:

- A literal, arithmetic, or logical constant
- Any type of variable or array element
- Any type of array name
- Any type of arithmetic or logical expression
- The name of a FUNCTION or SUBROUTINE subprogram
- A statement number

5.3.1.20 FUNCTION Subprogram

The FUNCTION subprogram is an independent subprogram consisting of a FUNCTION statement and at least one RETURN statement. It has the general form

type **FUNCTION** name*s(a1,a2,a3),...,

where

type is INTEGER, REAL, DOUBLE PRECISION, COMPLEX, or LOGICAL. Its inclusion is optional.

name is the name of the FUNCTION.

*s represents one of the permissible length specifications.

a is a dummy argument or dummay SUBROUTINE name or other FUNCTION subprogram.

5.3.1.21 Subscripts

A subscript is a set of integer subscript quantities that are associated with an array name to identify a particular element of the array. A maximum of seven subscript quantities, separated by commas, can appear in a subscript. The following rules apply to the construction of subscript quantities:

- Subscript quantities may contain arithmetic expressions that use any of the arithmetic operators: +, -, *, /, **
- Subscript quantities may contain FUNCTION references
- Subscript quantities may contain array elements
- Integer and real mixed-mode expressions within subscript quantities are evaluated according to normal FORTRAN rules. If the evaluated expression is real, it is converted to integer
- The evaluated result of a subscript quantity should always be greater than zero

5.3.1.22 Z Format Code

The hexadecimal Z format code causes a string of hexadecimal digits to be interpreted as a hexadecimal value and to be associated with the corresponding I/O list element for purposes of data transmitting. It has the general form

Zw .

where

w denotes a string of hexadecimal digits. The maximum value that can be read is FFFFFFFFFFFFFFFF

On input, if an input field contains an odd number of digits, the number will be padded on the left with a hexadecimal zero when it is stored.

On output, if the number of characters in the storage location is less than w, the left-most print positions are filled with blanks. If the number of characters in the storage location is greater than w, the left-most digits are truncated and the rest of the number is printed.

5.3.2 Execution-Time I/O Units

All FORTRAN I/O statements (FORTRAN IV manual) include a FORTRAN unit number (FUN) or name, which may or may not be identical with the logical unit containing the required file(s). Four different cases of FORTRAN units must be distinguished as indicated in figure 5-4.

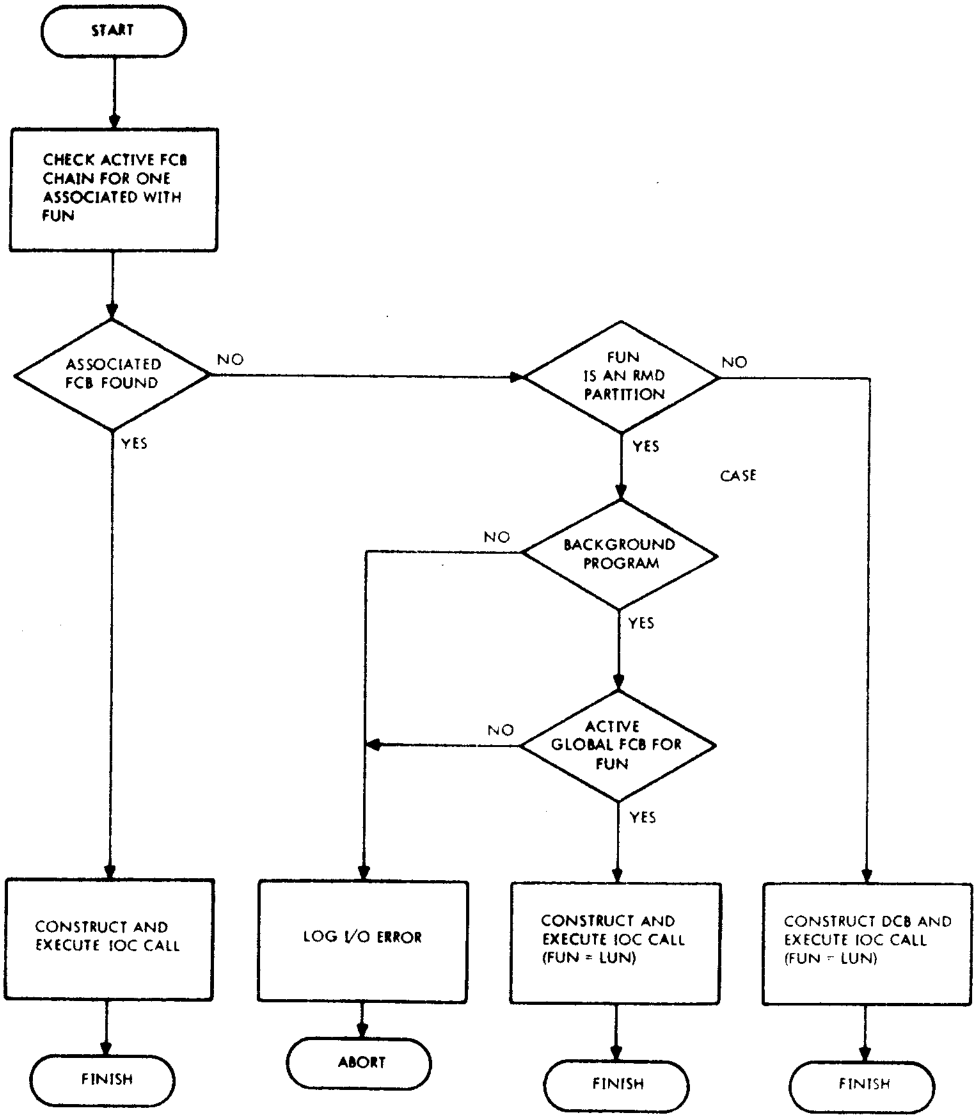
Case 1, non-RMD unit: The logical-unit number is assigned to the device by SGEN (section 15) or by the JCP /ASSIGN directive (section 4.2.6), where the FORTRAN unit number is identical with that of the file unit. Thus, to rewind the PO logical unit (unit 10, magnetic-tape unit 0), the job stack can be:

```
.
.
.
/ASSIGN,PO=MT00
/FORT
.
.
.
REWIND 10
.
.
```

•

Case 2, RMD file executing in background only: The JCP /PFILE directive (section 4.2.11) positions the PI unit to a background reassignable logical unit, and loads a global FCB. As in case 1, the FORTRAN unit number is identical with that of the file unit. Thus, to read the file FILE1 on logical unit 50 (protection code X) where PI is logical unit 4, the job stack can be:

```
/FORT,L,B
•
•
•
READ (4,...
•
•
END
```


START
CHECK ACTIVE FCB CHAIN FOR ONE ASSOCIATED WITH FUN
ASSOCIATED FCB FOUND
NO
YES
FUN IS AN RMD PARTITION
NO
YES
CASE
NO
BACKGROUND PROGRAM
YES
NO
ACTIVE GLOBAL FCB FOR FUN
YES
CONSTRUCT AND EXECUTE IOC CALL
LOG I/O ERROR
CONSTRUCT AND EXECUTE IOC CALL (FUN = LUN)
CONSTRUCT DCB AND EXECUTE IOC CALL (FUN = LUN)
FINISH
ABORT
FINISH
FINISH

NOTE: THE FORTRAN LOGICAL UNIT FUN IS NOT NECESSARILY IDENTICAL WITH THE FILE LOGICAL UNIT (LUN) UNLESS SO INDICATED. V$OPEN OVERRIDES A /PFILE ASSIGNMENT.

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Figure 5-4. FORTRAN I/O Execution Sequences

```
/ASSIGN,PI=50
/PFILE,4,X,FILE1
/EXECC
```

Case 3, normal RMD file executing in foreground or background: the CALL V$OPEN statement associates any specified RMD file with the FORTRAN unit number. The CALL V$OPEN statement cverrides any /PFILE assignment (case 2). The format of the statement is:

CALL V$OPEN(fun,lun,name,mode)

where

fun is the name or number of the FORTRAN unit which may be numeric value, defined by a DATA statement, or an assignment statement

lun is the name or number of the logical unit which may be numeric value, defined by a DATA statement, or an assignment statement

name is the name of the 13-word array containing the file name and the protection code

mode is the mode of the I/O-control open macro (section 3.5.1)

V$OPEN constructs an FCB in the first ten words of the specified 13-word array, performs an IOC OPEN on this FCB, and links it with the active FCB chain. The remaining three words of the array contain an FCB-chain link, the FORTRAN unit number, and the file logical unit number. Thus, to reference file FIL on logical unit 20 (protection code Q) by the number 2, rewinding upon opening, the job stack can be:

```
.
.
.
/FORT
.
.
.
DIMENSION IFCB(13)
DATA IFCB(3)/2H Q/
DATA IFCB(8),IFCB(9),IFCB(10)/2HFI,2HL ,2H /
.
.
.
CALL        V$OPEN(2,20,IFCB,0)
.
.
.
```

File FIL can now be referenced by FORTRAN statements by using 2 as the designation of the FORTRAN logical unit. For instance,

```
READ (2,...
```

executes an IOC READ call, reading from FIL using IFCB as the FCB.

Note: V$OPEN sets the record length to 120 words and the access method to 3, sequential access using relative VORTEX physical record number within the file. The user should not change the record length or access method parameters in the FCB because the FORTRAN Run-Time I/O package has reserved only a 120 word buffer.

Any record in a file opened by V$OPEN can be directly accessed by operating on the FCB array. Thus, using the job stack in the previous example, record 61 in file FIL is read by inputting

```
.
.
.
IFCB(4)=61
READ(2,...
.
.
.
```

To dissolve an existing association between an RMD file and a FORTRAN logical unit, use the CALL V$CLOS statement of the format.

CALL V$CLOS(fun,mode)

where

fun is the name or number of the FORTRAN logical unit

mode is the mode of the I/O-control CLOSE macro (section 3.5.2)

Thus, when the processing of file FIL in the previous example is complete, to close/update FIL and take IFCB off the active FCB chain so that FORTRAN statements with fun = 2 no longer reference FIL, the job stack can be:

```
.
.
.
CALL        V$CLOS(2,1)
.
.
.
```

Note: the auxiliary FORTRAN I/O statements REWIND, BACKSPACE, and ENDFILE cannot be used with RMD files. Use instead (where IFCB is the ECB array):

```
IFCB(4) = 1 For rewind
IFCB(4) = IFCB(4) -1 For backspace
CALL V$CLOS(fun, 1) For endfile
```

Case 4, **blocked RMD file executing in foreground or background:** the CALL V$OPNB statement associates any specified RMD file with a FORTRAN unit number. This statement overrides any /PFILE statement. The format is:

CALL V$OPNB (fun, lun, name, mode, recsz, buff, rbwfl)

where

fun is the name or number of the FORTRAN unit which may be numeric value, defined in a DATA statement, or an assignment statement

lun is the name or number of the file logical unit which may be numeric value, defined in a DATA statement, or an assignment statement

name is the name of a 14-word FCB array

mode is the mode of the I/O control OPEN macro

recsz is the logical record size in words

buff is the address of a blocking buffer array

rbwfl is the read-before-write flag

The first parameters are identical in function to those of the CALL V$OPEN statement. The other three specify blocking information.

An RMD file opened by a CALL V$OPNB statement is processed as though it were a consecutive series of logical records, each one **recsz** words in length. These logical records continue across physical record boundaries with no space wasted (except possibly at the end of file). Input and output is buffered through the user-supplied buffer array **buff** as specified above.

Since actual physical I/O is performed on **buff**, the file must be large enough to do I/O on the end of the last logical record. It is sufficient to allocate RMD space for one more logical record than will ever be used.

It is the user's responsibility to declare the size of the buffer array **buff** sufficiently large, remembering that it is a function of the logical record size **recsz**, that it must be a multiple of the basic record size of 120, and that it must be large enough to include enough basic 120-word physical records to cover a logical record, even though the physical record may overlap the physical record boundaries. The following tables specify all conditions, where:

Q(x/y) means the quotient of x/y
R(x/y) means the remainder of x/y

recsz < 120

R(120/**recsz**)	Size of Array **Buff**
= 0	120 words
≠ 0	240 words

recsz ≥ 120

R(**recsz**/120)	Size of Array **Buff**
= 0	recsz
= 1	120 * (1 + Q(**recsz**/120))
> 1	120 * (2 + Q(**recsz**/120))

If **recsz** is not a multiple or factor of 120 words, the blocking buffer **buff** must allow room for an extra 120-word physical record at the start or end of a logical record.

On a WRITE operation where **recsz** is not a multiple of 120 words, data on the RMD can be overwritten unless a read-before-write is performed. In some situations, such as initial file creation in a strictly sequential fashion, this is unnecessary and slow.

The parameter **rbwfl** allows the user to select this feature. If **rbwfl** is zero, read-before-write is disabled. Any non-zero value enables read-before-write.

Example: An RMD file opened by CALL V$OPNB can be accessed randomly, as with CALL V$OPEN, by a replacement statement using the logical record number.

```
/FORT
 DIMENSION IFCB(14),IBUFF(120)
DATA IFCB(3),IFCB(8),IFCB(9),IFCB(10)
     /0,2HBL,2HFI,2HLE/
CALL V$OPNB(2, 10, IFCB, 0, 10, IBUFF, 1)
IFCB(4) = 5
READ (2) I
READ (2) J
```

This sequence causes the unkeyed file name BLFILE on logical unit 10 to be opened and assigned FORTRAN unit number 2. The first READ statement causes the entire first 120-word physical record (first 12 logical records) to be input into blocking buffer IBUFF, and the first word of the fifth logical record to be transferred to I . The second READ would not require another physical input for record 6 in IBUFF. This READ statement would simply transfer the first word of logical record 6 to J.

To flush the blocking buffer, close the file and disassociate the FORTRAN and logical unit numbers the CALL V$CLSB statement is provided. Its format is:

CALL V$CLSB (fun,mode)

where

fun is the FORTRAN unit number

mode is the mode of the I/O control CLOSE macro

The end-of-file information in a FILE NAME DIRECTORY refers to a physical 120-word record number. Therefore, if logical record size is not a multiple of 120 words, the user may need to define his own end-of-file mark. Close and Update, Open and Leave, and IOCHK (section 5.3.4) EOF features all operate on this File Name Directory parameter referring strictly to 120-word physical record numbers.

5.3.3 Runtime I/O Exceptions

The FORTRAN runtime I/O program allows a program to detect I/O errors and end-of-file or end-of-device conditions. Status of a READ or WRITE operation is available immediately after the operation is complete and before another I/O operation is executed. This status can be checked by executing a subroutine or function call in the form.

CALL IOCHK(status)

where status is the name of an integer variable which is to receive the result of the status check.

If the last I/O operation had been completed normally, the value of zero will be returned. If an error had occurred, the value minus one is returned. If either an end-of-file or an end-of-device had occurred, the value positive one will be returned.

The status may be checked and the result tested in a single statement by use of the form:

IF (IOCHK(status)) label(1), label(2), label(3)

where

status is the name of an integer variable which receives the result of the status check. A value of zero indicates normal completion. A negative non-zero value indicates an error. A positive non-zero value indicates EOF or EOD.

label(1) is a statement label to which control is transferred, if an I/O error occurred.

label(2) is a statement label to which control is to be transferred if the operation was completed normally.

label(3) is a statement label to which control is transferred, if an end-of-file or end-of-device was encountered.

If the program does not check the status of a READ or WRITE operation in which an error occurs, FORTRAN will abort execution of the task upon the next entry to the runtime I/O routine. At that time the diagnostic message will be output to the System Output device. Any data which is input to a read in which an error occurred will be invalid. After a call to IOCHK is executed, any error status is reset and the program may proceed with additional input and/or output.

5.3.4 Reentrant Runtime I/O

The VORTEX runtime I/O program processes all FORTRAN READ, WRITE, auxiliary I/O, and open and close statements at execution time. It is composed of two modules, V$FORTIO and the reentrant task V$RERR. Both are in the OM library. V$RERR is also in the nucleus portion of the SGL. SGEN then automatically loads V$RERR in the VORTEX nucleus, and all FORTRAN programs automatically link to it. If V$RERR is not desired in the VORTEX nucleus, the SGEN directive DEL, V$RERR must be entered during system generation. Each FORTRAN program will then get its own copy of V$RERR from the OM library. V$RERR is approximately 3K words long.

5.4 RPG IV COMPILER

5.4.1 Introduction

The VORTEX RPG IV System is a software package for general data processing applications. It combines verstile file and record defining capabilities with powerful processing statements to solve a wide range of applications. It is particularly effective in processing data for reports. The VORTEX RPG IV system consists of the RPG IV compiler and RPG IV runtime/loader program.

The VORTEX RPG IV compiler and the runtime/loader execute as level zero background programs in unprotected memory. Both the compiler and the runtime/loader will operate in 6K of memory with limited work stack space. The stack space may be expanded and consequently larger RPG programs compiled and executed by use of the /MEM directive.

The RPG language, and its compilation and execution under VORTEX is described in the Varian 620 RPG IV User's Manual (98 A 9947 03x).

Error messages applicable to the RPG IV compiler are given in Appendix A.

5.4.2 RPG IV I/O Units

The RPG IV compiler reads source records from the Processor Input (PI) file, write object records on the Binary Output (BO) file, and lists the source program on the List Output (LO) file.

The RPG IV runtime/loader will normally load the RPG object program from the Binary Input (BI) file. When the program executes, the READ CARD, PUNCH and PRINT statements are performed on logical units 13, 14, and 15 respectively, statements for performing input and output to logical units 16 through 22.

5.4.3 Compiler and Runtime Execution

The RPG compiler and the runtime package should be cataloged into the background library (BL) using LMGEN.

The compiler and runtime package should be defined as background unprotected tasks with the names PRGC and RPGRT, respectively.

The compiler is scheduled from the background library by the directive

```
/LOAD,RPGC
```

The compiler terminates when the required END statement in the RPG program is encountered. The compiler exits to the executive. There is no provision for stacking multiple compilations or for operating in compile-and-go mode.

The compiler rewinds the PI, BO, and LO files at the beginning of the compilation.

The runtime/loader is scheduled from the background library by the directive

```
/LOAD,RPGRT
```

The loader expects the RPG object program is on the Binary Input (BI), and loads and executes it. If the load directive contains the name of an RPG program to be loaded in the form,

```
/LOAD,RPGRT,name
```

the runtime/loader will assume the program mentioned is in the background library and will load it from there. An RPG object program may be 'cataloged' into the background library by creating a directory entry and allocating file space with FMAIN and copying the RPG object program into the file with IOUTIL.

5.5 RPG II COMPILER

5.5.1 Introduction

The VORTEX RPG II System is an industry compatible software package for general data processing applications. It combines versatile file and record defining capabilities with powerful processing statements to solve a wide range of applications. It is particulary effective in processing data for reports. The VORTEX RPG II system consists of the RPG II compiler and RPG II runtime interpreter.

The VORTEX RPG II compiler executes as a level one background program in unprotected memory. The compiler will operate in 4K of memory with limited work space. The work space may be expanded and consequently larger RPG programs may be compiled by use of the /MEM directive.

The RPG II language, and its compilation and execution under VORTEX is described in the RPG II User's Manual.

5.5.2 RPG II I/O Units

The RPG II compiler reads source records from the Processor Input (PI) file, writes object records on the Binary Output (BO) file, and lists the source program on the List Output (LO) file. Optionally, object records may be written on the GO file.

5.5.3 Compiler and Runtime Execution

The RPG II compiler and the runtime package should be cataloged into the background library (BL) using LMGEN.

The compiler and runtime package should be defined as a background unprotected task, with the name RPG.

The compiler is scheduled from the background library by the directive:

```
/RPG
```

The compiler terminates when the required /* statement in the RPG program is encountered. The compiler exits to the executive. There is no provision for stacking multiple compilations or for operating in compile-and-go mode.

The compiler rewinds PI, BO, and LO files at the beginning of the compilation.

An RPG object program may be 'cataloged' into the background library by creating a directory entry and allocating file space with FMAIN and copying the RPG object program into the file with IOUTIL

SECTION 6
LOAD-MODULE GENERATOR

The **load-module generator (LMGEN)** is a background task that generates background and foreground tasks from relocatable object modules. The tasks can be generated with or without overlays, and are in a form called **load modules**.

To be scheduled for execution within the VORTEX operating system, all tasks must be generated as load modules.

6.1 ORGANIZATION

LMGEN is scheduled for execution by inputting the job-control processor (JCP) directive /LMGEN (section 4.2.19).

LMGEN has a symbol-table area for 200 symbols at five words per symbol. To increase this area, input a /MEM directive (section 4.2.5), where each 512-word block will enlarge the capacity of the table by 100 symbols.

INPUTS to the LMGEN comprise:

- *Load-module generator directives* (section 6.2) input through the SI logical unit.
- *Relocatable object modules* from which the load module is generated.
- *Error-recovery inputs* entered via the SO logical unit.

Load-module generator directives define the load module to be generated. They specify the task types (unprotected background or protected foreground) and the locations of the object modules to be used for generation of the load modules. The directives supply information for the cataloging of files, i.e., for storage of the files and the generation of file-directory entries for them. LMGEN directives also provide overlay and loading information. The directives are input through the SI logical unit and listed on the LO logical unit. If the SI logical unit is a Teletype or a CRT device, the message **LM**** is output on it to indicate that the SI unit is waiting for LMGEN input.

Relocatable object modules are used by LMGEN to generate the load modules. The outputs from both the DAS MR assembler and the FORTRAN compiler are in the form of relocatable object modules. Relocatable object modules can reside on any VORTEX system logical unit and are loaded until an end-of-file mark is found. The last execution address encountered while generating a segment (root or overlay, section 6.1.1) becomes the execution address for that segment. (**Note:** If the load module being generated is a foreground task, no object module loaded can contain instructions that use addressing modes utilizing the first 2K of memory, other than the base page (page 0). No assembler generated indirects or literals are allowed.

A VORTEX physical record on an RMD is 120 words. Object-module records are blocked two 60-word records per VORTEX physical record. However, in the case of an RMD assigned as the SI logical unit, object modules are not blocked but assumed to be one object module record per physical record.

Error-recovery inputs are entered by the operator on the SO logical unit to recover from errors in load-module generation. Error messages applicable to this component are given in Appendix A.6.

Recovery from the type of error represented by invalid directives or parameters is by either of the following:

a. Input the character C on the SO unit, thus directing LMGEN to go to the SI unit for the next directive.

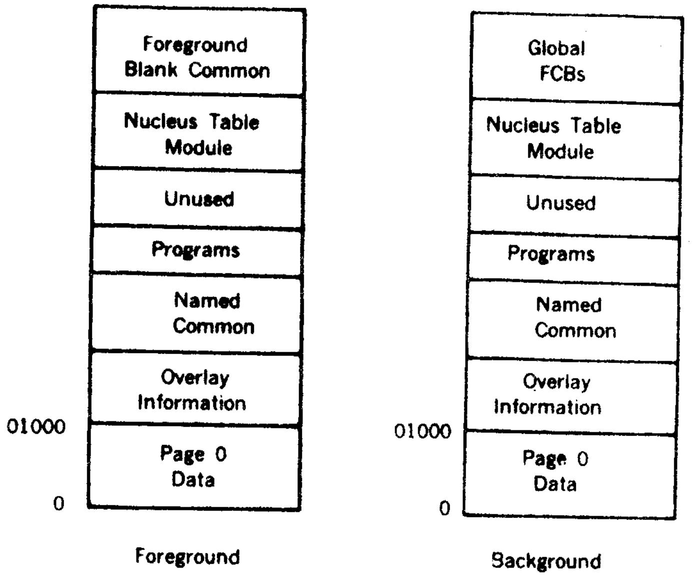
b. Input the corrected directive on the SO unit for processing. The next LMGEN directive is then input from the SI unit.

If recovery is not desired, input a JCP directive (section 4.2) on the SO unit to abort the LMGEN task and schedule the JCP for execution. (**Note:** An irrecoverable error, e.g., I/O device failure, causes LMGEN to abort. Examine the I/O error messages and directive inputs to determine the source of such an error.)

OUTPUTS from the LMGEN comprise:

- *Load modules* generated by the LMGEN
- *Error messages*
- *Load-module maps* output upon completion of a load-module generation

Load modules are LMGEN-generated absolute or relocatable tasks with or without overlays. They contain all information required for execution under the VORTEX operating system. During their generation, LMGEN uses the SW logical unit as a work unit. Upon completion of the load-module generation, the module is thus resident on the SW unit. LMGEN can then specify that the module be cataloged on another unit, if required, and output the load module to that unit. Figure 6-1 shows the structure of a load module.



All foreground tasks share the foreground blank common area but may have their own named common area.

Figure 6-1. Load-Module Overlay Structure (virtual memory)

Note: LMGEN locks out the partition while it is modifying the directory.

Error messages applicable to the load-module generator are output on the SO and LO logical units. The individual messages, errors, and possible recovery actions are given in appendix A.6.

Load-module maps are output on the LO logical unit upon completion of the load-module generation, unless suppressed. The maps show all entry and external names and labeled data blocks. They also describe the items given as defined or undefined, and as absolute or relocatable, and indicate the relative location of the items. The load-module map lists the items in the format, four entries per line:

Print position	2 3 4 5 6 7 8	9	10	11	12 13 14 15 16
	item	*b*	*x*	*b*	*location*

where

item is a left-justified entry or external name or labeled data block

b is a blank

x is A for an absolute or R for a relocatable item

location is the left-justified relative location of the item

The following appear at the end of the LMGEN map.

[$IAP]	Top of indirect address pool, which begins at 0500
[$LIT]	Bottom of literal pool, which begins at 0777
[$PED]	Last loaded location. Foreground, word size of load module. Background, last location loaded (loading begins at 01000).

LMGEN performs special handling for an external of the form 'V$PED'. LMGEN satisfies this external with the last loaded location plus one of the load modules for both overlayed and non-overlayed tasks. This external can be used for specifying table areas behind tasks that link with external routines.

6.1.1 Overlays

Load modules can be generated with or without overlays. Load modules with overlays are generated when task requirements exceed core allocation. In this case, the task is divided into overlay segments that can be called as required. Load modules with overlays are generated by use of the OV directive (section 6.2.3) and comprise a root segment and two or more overlay segments (figure 6-1), but only the root segment and one overlay segment can be in memory at any given time. Overlays can contain executable codes, data, or both.

When a load module with overlays is loaded, control transfers to the root segment, which is in main memory. The root segment can then call overlay segments as required.

Called overlay segments may or may not be executed, depending on the nature of the segment. It can be an executable routine, or it can be a table called for searching or manipulation, for example. Whether or not the segment consists of executable data, it must have an entry point.

The generation of the load module begins with the root segment, but overlay segments can be generated in any order.

The root segment can reference only addresses contained within itself. An overlay segment can reference addresses contained within itself or within the root segment. Thus, all entry points referenced within the root segment or an overlay segment are defined for that segment and segments subordinate to it, if any.

For an explanation of DAS MR and FORTRAN calls to overlays see section 2.1.8.

6.1.2 Common

Common is the area of memory used by linked programs for data storage, i.e., an area common to more than one program. There are two types of common: named common and blank common. (Refer to the FORTRAN IV Reference Manual, document number 98 A 9902 03x, or the DAS MR COMN directive description in the computer handbook, for the system being used.

Named common is contained within a task and is used for communication among the subprograms within that task.

Blank common can be used like named common or for communication among foreground tasks.

The extent of blank common for foreground tasks is determined at system generation time. The size of the foreground blank common can vary within each task without disturbing the positional relationship of entries but cannot exceed the limits set at system generation time.

The extent of blank common for background tasks is allocated within the load module. The size of the background blank common can vary within each task, but the combined area of the load module and common cannot exceed available memory.

Each blank common is accessible only by the corresponding tasks, i.e., foreground tasks use only foreground blank common, and background tasks use only background blank common.

All definitions of named and blank common areas for a given load module must be in the first object module loaded to generate that load module.

6.2 LOAD-MODULE GENERATOR DIRECTIVES

- TIDB Create task-identification block
- LD Load relocatable object modules
- OV Overlay
- LIB Library search
- CLD Load relocatable object modules without re-opening or repositioning
- MEM Default extra memory pages
- END

Load-module generator directives begin in column 1 and comprise sequences of character strings having no embedded blanks. The character strings are separated by commas (,) or by equal signs (=). The directives are free-form and blanks are permitted between the individual character strings of the directives, i.e., before or after commas (or equal signs). Although not required, a period (.) is a line terminator. Comments can be inserted after the period.

The general form of a load-module generator directive is

name,*p(1),p(2),...,p(n)*

where

name is one of the directive names given above

each *p(n)* (if any) is a parameter required by the directive and defined below under the descriptions of the individual directives

Numerical data can be octal or decimal. Each octal number has a leading zero.

For greater clarity in the descriptions of the directives, optional periods, optional blank separators between character strings, and the optional replacement of commas (,) by equal signs (=) are omitted.

Error messages applicable to load-module generator directives are given in Appendix A.6.

6.2.1 TIDB (Task-Identification Block) Directive

This directive must be input before any other LMGEN directives can be accepted. It permits task scheduling and execution, and specifies the overlay and debugging characteristics of the task. The directive has the general form

TIDB,name,type,segments,*DEBUG*, **ropages**

where

name is the name (1 to 6 ASCII characters) of the task

type is 1 for an unprotected background task on BL, or 2 for a protected foreground task or 3 for a background task on an alternate library

segments is the number (2 to 9999) of overlay segments in a task with overlays, or 0 for a task without overlays (note that the number 1 is invalid)

DEBUG is present when debugging is desired

ropages is an optional ready-only page specifier (1-77). It can be a single number or a range of consecutive numbers (e.g., 3,5).

The *DEBUG* parameter includes the DEBUG object module as part of the task. If the task is a load module without overlays, DEBUG is the last object module loaded. If the task is a load module with overlays, DEBUG is the last object module loaded in the root segment (section 6.1.1).

The **ropage** parameter allows specification of a range of virtual pages as read-only.

Examples: Specify an unprotected background task named DUMP as having no overlays but with debugging capability.

```
TIDB,DUMP,1,0,DEBUG
```

Specify a protected foreground task named PROC as having a root segment and four overlay segments.

```
TIDB,PROC,2,4
```

6.2.2 LD (Load) Directive

This directive specifies the logical unit from which relocatable object modules are to be loaded. It has the general form

LD,lun,*key,file*

for loading from RMD logical units, and

LD,lun

for loading from any other logical unit, where

lun is the name or number of the logical unit where the object module resides

key is the protection code required to address **lun**

file is the name of the RMD file

From the object modules, LMGEN generates load modules (with or without overlays) on the SW logical unit. Loading of object modules from the specified logical unit continues until an end-of-file mark or an end-of-load module record (appendix G.6) is encountered.

Successive LD directives permit the loading of object modules that reside on different logical units. The execution address for the load module is the last encounter execution address.

Examples: Load the relocatable object modules from logical unit 6 (BI) until an end-of-file mark is encountered.

```
LD,6
```

Open a file named DUMP on logical unit 9 (GO) with no protection code. (LMGEN loads the relocatable object modules and closes the file.)

```
LD,9,,DUMP
```

6.2.3 OV (Overlay) Directive

This directive specifies that the named segment is an overlay segment. It has the general form

OV,segname

where **segname** is the name (1 to 6 ASCII characters) of the overlay segment.

Example: Specify SINE as an overlay segment.

```
OV,SINE
```

6.2.4 LIB (Library) Directive

This directive indicates that all load (LD, section 6.2.2) directives have been input, i.e., all object modules have been loaded except those required to satisfy undefined externals. LIB also specifies the libraries to be searched (and the order in which the search is made) to satisfy all undefined externals. The directive has the general form

LIB,*lun(1)*,*key(1)*,*lun(2)*,*key(2)*,...,*lun(n)*,*key(n)*

where

each *lun(n)* is the name or number of a resident-library RMD logical unit to be searched

each *key(n)* is the protection code required to address the preceding logical unit

The search is conducted in the order in which the logical units are given in the LIB directive. When not specified by LIB, the core-resident (CL) and object-module (OM) libraries are searched after all specified libraries have been searched. However, if LIB specifies the CL and/or OM libraries, they are searched in the order given in LIB.

If the generation of the load module involves overlays, a LIB directive follows each overlay generation.

Examples: Specify to the LMGEN a sequence of libraries to be searched to satisfy undefined externals. Use logical unit 115, a user library, having protection code M; followed by logical unit 103, the CL library, having protection code C; and the OM library, having protection code D. (Because the last two libraries are searched in any case, note that the two inputs following are equivalent.) Input

```
LIB,115,M,103,C,104,D
```

or, more briefly,

```
LIB,115,M
```

To change the order of search to logical units 104, 115, and 103, input

```
LIB,104,D,115,M,103,C
```

or, more briefly,

```
LIB,104,D,115,M
```

To search only the CL and OM libraries to satisfy undefined externals, input

```
LIB
```

6.2.5 END Directive

This directive terminates the generation of the load module and, if specified, causes the creation of a file and a directory entry (section 9) for the load-module contents on the indicated logical unit. The indicated logical unit, if any, is an RMD, and thus may require a protection code. The directive has the general form

END,*lun*,*key*

where

lun is the name or number of the logical unit on which the file containing the load module will reside

key is the protection code, if any, required to address *lun*

If TIDB (section 6.2.1) specified an unprotected background task (TIDB directive **type** = 1), the logical unit, if any, specified by the END directive must be that of the BL unit, i.e., unit 105. If TIDB specified a protected foreground task (TIDB directive **type** = 2), the logical unit, if any, specified by the END directive must be that of the FL unit, i.e., unit 106, or that of any available assigned RMD partition. If TIDB specified an alternate library background task (TIDB directive type = 3), the logical unit, if any, specified by the END directive, may be that of any available assigned RMD partition.

If the END directive does not specify a logical unit, the load module resides on the SW logical unit only.

If there are still undefined externals, the load module is not cataloged even if END specifies a legal logical unit. In this case, the load module resides on the SW unit only.

Examples: Specify that the load module is complete (no more inputs to be made), create a file and a directory entry on the BL logical unit (105), and catalog the module. The protection code is E. (**Note:** The load module will also reside on the SW unit.)

```
END,105,E
```

Specify that the load module is complete (no more inputs to be made) and is to reside on the SW unit only.

```
END
```

6.2.6 CLD Directive

This directive specifies the logical unit from which relocatable object modules are to be loaded. It has the general forms

CLD,lun,*key,file*

or

CLD,lun

Where use of the two forms and the meaning of lun, key, and file is as for the LD directive (section 6.2.2). This directive specifies the same action as for the LD directive except that successive CLD directives do not cause re-opening or repositioning of the specified logical unit.

6.2.7 MEM (Memory) Directive

This optional directive is used to specify the default number of extra memory blocks to be attached to a background task in a similar manner to the /MEM directive of JCP. This value is in addition to a /MEM request and is stored in word 12 of the task's pseudo TIDB. The directive has the general form

MEM,n

where

n is the number of 512 word blocks (pages)

This directive, if used, must appear after the last LIB directive and before the END directive.

6.3 SAMPLE DECKS FOR LMGEN OPERATIONS

Example 1: Card and Teletype Input

Generate a background task without overlays using LMGEN with control records input from the Teletype and object module(s) on cards. Assign the BI logical unit to card reader unit CR00. Assign the task name EXC4 and catalog to the BL logical unit, and load DEBUG as part of the task from the OM library.

```
/JOB,EXAMPLE4          (Teletype input)
/ASSIGN,BI=CR00
/LMGEN
TIDB,EXC4,1,0,DEBUG
LD,BI
LIB
END,BL,E
/ENDJOB
```

Note: The object module deck must be followed by an end of file (2-7-8-9 in card column 1).

Example 2: Card Input

Generate a foreground task with overlays using LMGEN with control records and object modules input from the card reader. Assign the BI and SI logical units to card reader unit CR00. Assign the task name EXC5, overlay names SGM1, SGM2, and SGM3, and catalog to the FL logical unit.

```
/JOB,EXAMPLE5
/ASSIGN,BI=CR00,SI=CR00
      •
    (Deck)
      •
/LMGEN
TIDB,EXC5,2,3
LD,BI
(Object Module(s) -- root segment)
  (End of File)
LIB
OV,SGM1
LD,BI
(Object Module(s))
  (End of File)
LIB
OV,SGM2
LD,BI
(Object Module(s))
  (End of File)
LIB
OV,SGM3
LD,BI
(Object Module(s))
  (End of File)
LIB
END,FL,F
/ENDJOB
```

Example 3: Teletype and RMD Input

Generate a foreground task without overlays using LMGEN with control records input from the Teletype and object module(s) from an RMD. The object module resides on RMD 107 under the name PGEX. Assign the task name EXC6, search the OM library first to satisfy any undefined externals, and catalog on RMD 120.

```
/JOB,EXAMPLE6
/LMGEN
TIDB,EXC6,2,0
LD,107,Z,PGEX
LIB,OM,D
END,120,X
/ENDJOB
```

SECTION 7
DEBUGGING AIDS

The VORTEX II system contains two debugging aids: the *debugging program (DEBUG)* and the *snapshot dump program (SNAP).*

7.1 DEBUGGING PROGRAM

The 816-word VORTEX debugging program (DEBUG) is added to a task load module whenever the DEBUG option is specified by a load-module generator TIDB directive (section 6.2.1). The DEBUG object module is the last object module loaded of the root segment if the task is an overlay load module. The load-module generator sets the load-module execution address equal to that of DEBUG.

If the load module has been cataloged, DEBUG executes when the module is scheduled. Otherwise, JCP directive /EXEC (section 4.2.22) is used to schedule the module and DEBUG (level zero only).

During the execution of DEBUG, the A, B, and X pseudoregisters save the contents of the real A, B, and X registers, and restore the contents of these registers before terminating DEBUG. If the task uses V75 registers, the contents of R3 through R7 are also saved and restored.

When debugging is complete, the input of any job-control directive (section 4.2) returns control to the VORTEX system.

INPUTS to DEBUG comprise the directives summarized in table 7-1 input through the DI logical unit. When DEBUG is first entered, it outputs on the Teletype or CRT device the message **DG**** followed by the TIDB task name and the address of the first allocatable memory cell. This message indicates that the system is ready to accept DEBUG directives on the DI unit.

Table 7-1. DEBUG Directives

Directive	Description
A	Display and change the contents of the A pseudoregister
Ax	Change, but do not display, the contents of the A pseudoregister
B	Display and change the contents of the B pseudoregister
Bx	Change, but do not display, the contents of the B pseudoregister
*Rn	Display and change the contents of the V75 register n (n = 0-7).
*Rnx	Change, but do not display, the contents of the V75 register n.
Cx	Display and change the contents of memory address x
Gx	Load the contents of the pseudoregisters into the respective A, B, and X registers, and transfer to memory address x
Ix,y,z	Initialize memory addresses x through y with the value of z
O	Display and change the overflow indicator
P	Read DEBUG directives from BI unit until EOF
Sx,y,z,m	Search memory addresses x through y for the z value, using mask m
Ty,x	Place a trap at memory address y, starting execution at address x

Table 7-1. DEBUG Directives *(continued)*

Directive	Description
Ty	Place a trap at memory address y, starting execution at the last trap location
X	Display and change the contents of the X pseudoregister
Xy	Change, but do not display, the contents of the X pseudoregister
xxxxxx	Display the contents of memory address xxxxxx
xxxxxx,yyyyyy	Display the contents of memory addresses xxxxxx through yyyyyy

* = V75 systems only

Each DEBUG directive has from 0 to 72 characters and is terminated by a carriage return. Directive parameters are separated by commas, but DEBUG treats commas, periods, and equal signs as delimiters.

Numerical data are always interpreted as octal by DEBUG. Negative numbers are accepted, but they are converted to their two's complements by DEBUG.

An error message, EX20-EX25, is output and the task is aborted, if a memory-map protection violation occurs.

OUTPUTS from DEBUG consist of corrections to registers and memory, displays, listings on the DO logical unit, and error messages. Numerical data are always to be interpreted as octal.

Error messages applicable to the debugging program are given in Appendix A.7.

Examples of DEBUG directive usage: Note that, in the following examples, operator inputs are in **bold** type. Entries in *italics*, are program responses to the directives.

Display the contents of a pseudoregister A:

A
(001200)

Display and change the contents of a pseudoregister B:

B
(001200) **010406**

Change, but do not display, the contents of a pseudoregister X:

X02050

Display, but do not change, the status of the overflow indicator:

O
(000001)

Display and change the status of the overflow indicator:

O
(000000) **000001**

Display, but do not change, the contents of memory address 002050:

C002050
(102401)

Display and change the contents of memory address 002050:

C002050
(102401)
001234

Display and change the contents of memory address 002050, then display the contents of the next sequential location:

C002050
(102401)
001234,
(000067)

Display, but do not change, the contents of memory address 002050, then display the contents of the next location:

C002050
(102401),
(000067)

Load the contents of the pseudoregisters into the respective A, B, and X registers, and start execution at memory address 001001:

```
G001001
```

Initialize memory addresses 000200 through 000210 to the value 077777:

```
I000200,000210,077777
```

Search memory addresses 000200 through 000240 for the value 000110 using the mask 000770, and display addresses that compare:

```
S000200,000240,000110,000770
000220 (017110)
000234 (000110)
000237 (001110)
```

Load the contents of the pseudoregisters and the overflow indicator status into the respective registers, and start execution at memory address 001234, specifying a trap address of 001236. Display the contents of the A, B, and X registers and the setting of the overflow indicator when the trap address is encountered:

```
T001236,001234
001236 (142340) 002000 010405 012345 000001
```

Execute the same trap if the task uses V75 instructions (assuming Rn = n):

```
T001236,001234
001236 (142340) 002000 010405 012345 000001
000003 000004 000005 000006 000007
```

Display the contents of memory address 001234:

```
001234
(001200)
```

Display the contents of memory addresses 001234 through 001237:

```
001234,001237
001230 005000    . . . . . .        005000
       \___________________________/
             Total of 8 values
```

7.2 SNAPSHOT DUMP PROGRAM

The 294-word **snapshot dump program (SNAP)** provides on the DO logical unit both register displays and the contents of specified areas of memory. It is added to a task load module if the task contains a SNAP request and calls the SNAP external routine. SNAP is entered directly upon execution of the SNAP display request CALL SNAP. The SNAP display request is an integral part of the task and is assembled with the task directives. Thus, no external intervention is required to output a SNAP display.

SNAP outputs the message SN** followed by the task TIDB name before listing the requested items. The calling sequence for a SNAP display is

```
EXT     SNAP
CALL    SNAP
DATA    start
DATA    end
DATA    tidb
```

where

start is the first address whose contents are to be displayed

end is the last address whose contents are to be displayed

tidb is less than zero if dump of task TIDB is desired, is positive if TIDB dump is to be suppressed

If **start** is a negative number, there is no memory dump. If more than one location is specified to be displayed, the output dump will be in complete lines of eight addresses, e.g., if **start** is 01231 and **end** is 01236, the dump will display the contents of addresses 01230 through 01237, inclusive. SNAP displays octal data.

If there is an error in the SNAP display request, only the contents of the A, B, and X (and V75 if present) registers and the setting of the overflow indicator are displayed.

Output examples: with the snap request at 01234, display the contents of the A (017770), B (001244), and X (037576) registers, and the overflow indicator (on).

```
SN** TASK01
001234 017770 001244 037576 000001
*000003 000004 000005 000006 000007
```

Using the same data, display, in addition, the contents of memory addresses 001002 through 001025, inclusive and request a dump of the active TIDB.

```
 SN**  SW        000500
 001023   000000    000000   001023   000000
*000003   000004    000005   000006   000007


 TIDB LOC 055013 =CONTENTS=

 055010   000000    000000   000000    000000   000001   000000   000000   001527
 055020   001527    067001   001326    141146   001000   065604   000007   001302
 055030   000001    001541   000002    000000   002000   151727   120240   120240
 055040   000500    000000   074627    064604   055075   000003   000004   000005
*055050   000006    000007   000000    000000   000000   000000   000000   000000

 SNAP DUMP
 001000   006505    070275   001402    001031   000050   006505   066270   100000
 001010   010002    075334   000000    000000   006505   070137   001005   001101
 001020   001101    001101   001014    002000   001107   001000   001027   001000
```

* These lines appear only if the task uses V75 register

SECTION 8
SOURCE EDITOR

The VORTEX operating system **source editor (SEDIT)** is a background task that constructs sequenced or listed output files by selectively copying sequences of records from one or more input files. SEDIT operates on the principle of forward-merging of subfiles and has file-positioning capability. The output file can be sequenced and/or listed.

8.1 ORGANIZATION

SEDIT is scheduled by the job-control processor (JCP, section 4.2.17) upon input of the JCP directive /SEDIT. Once activated, SEDIT inputs and executes directives from the SI logical unit until another JCP directive (first character = /) is input, at which time SEDIT terminates and the JCP is again scheduled.

SEDIT has a buffer area for 100 source records in MOVE operations (section 8.2.8). To increase this, input a /MEM directive (section 4.2.5), immediately preceding the /SEDIT directive, where each 512-word block will increase the capacity of the buffer area by 12 source records.

INPUTS to SEDIT comprise:

a. *Source-editor directives* (section 8.2) input through the SI logical unit.

b. *Old source records* input through the IN logical unit.

c. *New or replacement source records* input through the ALT logical unit.

d. *Error-recovery inputs* entered via the SO logical unit.

Source-editor directives specify both the changes to be made in the source records, and the logical units to be used in making these changes. The directives are input through the SI logical unit and listed as read on the LO logical unit, with the VORTEX standard heading at the top of each page. If the SI logical unit is a Teletype or a CRT device, the message **SE**** is output to it before directive input to indicate that the SI unit is waiting for SEDIT input.

There are two groups of source-editor directives: the copying group and the auxiliary group. **The copying group directives** copy or delete source records input on the IN logical unit, merge them with new or replacement source records input on the ALT unit, and output the results on the OUT unit. Copying-group directives must appear in sequence according to their positioning-record number since there is no reverse positioning. If the remainder of the source records on the IN unit are to be copied after all editing is completed, this must be explicitly stated by an FC directive, (section 8.2.9). Ends of file are output only when specified by FC or WE directives (sections 8.2.9 and 8.2.13). The processing of string-editing directives is different from that of record-editing directives. A string-editing directive affects a specified record, where source records on the IN unit are copied onto the OUT unit until the specified record is found and read into memory from the IN unit. After editing, this record remains in memory and is not yet copied onto the OUT unit. This makes possible multiple field-editing operations on a single source record. **The auxiliary group directives** are those used for special I/O or control functions.

All source records, whether old, new, or replacement records, are arranged in blocks of three 40-word records per VORTEX RMD physical record. Any unused portion of the last physical record of an RMD file on the IN unit should be padded with blanks. When necessary, SEDIT will pad the last RMD record on the OUT unit. When the OUT file will contain more than one source module for input to a language processor, the user should insert two blank records after each END statement to insure that each source module starts on a physical record boundary. Record numbers start with 1 and have a maximum of 9999. Sequence numbers start at any value less than the maximum 9999, and can be increased by any integral increment. These specifications for sequence numbers are given by the SE directive (section 8.2.10).

Error-recovery inputs are entered by the operator on the SO logical unit to recover from errors in SEDIT operations. Error messages applicable to this component are given in Appendix A.8. Recovery is by either of the following:

a. Input the character C on the SO unit, thus directing SEDIT to go to the SI unit for the next directive.

b. Input the corrected directive on the SO unit for processing. The next SEDIT directive is then input from the SI unit.

If recovery is not desired, input a JCP directive (section 4.2) on the SO unit to abort the SEDIT task and schedule the JCP for execution. (Note: If there is an I/O control error on the SO unit, SEDIT is terminated automatically.)

OUTPUTS from the SEDIT comprise:

a. *Edited source-record sequences* output on the OUT logical unit.

b. *Error messages.*

c. *The listing of the SEDIT directives* on the LO logical unit.

d. *Comparison outputs* (compare-inputs directive. section 8.2.15).

e. Listing of source records on the LO logical unit when specified by the LI directive (section 8.2.11).

Error messages applicable to SEDIT are output on the SO and LO logical units. The individual messages and errors are given in Appendix A.8.

The listing of the SEDIT directives is made as the directives are read. Source records, when listed, are listed as they are input or output. The VORTEX standard heading appears at the top of each page of the listing.

LOGICAL UNITS referenced by SEDIT are either fixed or reassignable units. The three fixed logical units are:

a. **The SI logical unit**, which is the normal input unit for SEDIT directives.

b. **The SO logical unit**, which is used for error-processing.

c. **The LO logical unit**, which is the output unit for SEDIT listings.

The three reassignable logical units are:

a. **The SEDIT input (IN) logical unit**, which is the normal input unit for source records. This is assigned to the PI logical unit when SEDIT is loaded, but the assignment can be changed by an AS directive with an IN parameter (section 8.2.1).

b. **The SEDIT output (OUT) logical unit**, which is the normal output unit for source records. This is assigned to the PO logical unit when SEDIT is loaded, but the assignment can be changed by an AS directive with an OU parameter.

c. **The SEDIT alternate input (ALT) logical unit**, which is the alternate input unit used for new or replacement source records. This is assigned to the BI logical unit when SEDIT is loaded, but the assignment can be changed by an AS directive with an AL parameter.

8.2 SOURCE-EDITOR DIRECTIVES

This section describes the SEDIT directives:

a. Copying group:

•	**AS**	Assign logical units
•	**AD**	Add record(s)
•	**SA**	Add string
•	**REPL**	Replace record(s)
•	**SR**	Replace string
•	**DE**	Delete record(s)
•	**SD**	Delete string
•	**MO**	Move record(s)

b. Auxiliary group:

•	**FC**	Copy file
•	**SE**	Sequence records
•	**LI**	List records
•	**GA**	Gang-load all records
•	**WE**	Write end-of-file
•	**REWI**	Rewind
•	**CO**	Compare records

SEDIT directives begin in column 1 and comprise sequences of character strings having no embedded blanks. The character strings are separated by commas (,) or by equal signs (=). The directives are free-form and blanks are permitted between individual character strings of the directive, i.e., before or after commas (or equal signs). Although not required, a period (.) is a line terminator. Comments can be inserted after the period.

The general form of an SEDIT directive is

name,*p(1)*,*p(2)*,...,*p(n)*

where

name is one of the directive names given above or a longer string beginning with one of the directives names (e.g., AS or ASSIGN)

each *p(n)* is a parameter defined below under the descriptions of the individual directives

Where applicable in the following descriptions, a field specification of the format (**first,last**) or (**n1,n2,n3**) is still separated from other parameters by parentheses even though it is enclosed in commas. Note also that the character string **string** is coded within single quotation marks, which are, of course, neither a part of the string itself nor of the character count for the string.

8.2.1 AS (Assign Logical Units) Directive

This directive specifies a unit assignment for an SEDIT reassignable logical unit (section 8.1). It has the general form

AS,nn = lun,*key*,*file*

where

nn is **IN** if the directive is making an assignment of the IN logical unit, **OU** if the OUT logical unit, or **AL** if the ALT logical unit

lun is the name or number of the logical unit being assigned as the IN, OUT, or ALT unit

key is the protection code, if any, required to address **lun**

file is the name of an RMD file, if required

If the SEDIT reassignable units are to retain the assignments made when SEDIT was loaded (default assignments: IN = PI, OUT = PO, ALT = BI), no AS directive is required. Each AS directive can make only one reassignment (e.g., if both IN and OUT are to be reassigned, two AS directives are required).

Any RMD affected by an AS directive is automatically repositioned to beginning of device.

The AS directive merely fixes parameters in I/O control calls within SEDIT. It does not alter I/O control assignments in the logical-unit table (table 3-1).

Note: AS resets the corresponding record counter; however, no physical rewinding of devices occurs.

Examples: Assign the PI logical unit as the SEDIT reassignable IN unit.

```
AS,IN=PI
```

or, the unabbreviated form

```
ASSIGN,INPUT=PI
```

Assign logical unit 8 as the SEDIT reassignable OUT unit.

```
AS,OU=8
```

Assign as the SEDIT reassignable IN unit the file FILEX on logical unit 111, an RMD partition without a protection key.

```
AS,IN=111,,FILEX
```

8.2.2 AD (Add Records) Directive

This directive adds source records. It has the general form

AD,recno

where **recno** is the number of the record last copied from the IN logical unit before switching to the ALT unit for further copying.

The AD directive copies source records from the IN logical unit onto the OUT logical unit beginning with the current position of the IN unit and continuing up to and including the record specified by **recno**. Then, source records are copied from ALT onto OUT from the current position of the unit up to but *not* including the next end-of-file mark.

Example: Copy records from IN onto OUT from the current position of IN up to and including IN record 7. Then, switch to ALT and copy records from the current position of that unit up to but *not* including the next end-of-file mark.

```
AD,7
```

8.2.3 SA (Add String) Directive

This directive inserts a character string into a source-record field. It has the general form

SA,recno,(first,last),'string'

where

recno is the number of the source record in which the character string is to be inserted

first is the number of the first character position to be affected

last is the number of the last character position to be affected

string is the string of characters to be inserted in the field delimited by character positions **first** and **last** in record number **recno**

The SA directive copies source records from the IN logical unit onto the OUT logical unit beginning with the current position of the IN unit and continuing up to but *not* including the record specified by **recno**. The record **recno** is read into the memory buffer. The character string **string** shifts into the left end of the specified field **first,last**, with characters shifted out of the right end of the field being lost. There is no check on the length of **string** and shifting continues until it is left-justified in the field with excess characters, if any, being truncated on the right.

The record remains in the memory buffer, thus permitting multiple string operations on the same record. (If IN is already positioned at **recno** because of a previous string operation, there is, of course, no change in position.)

The record **recno** is read out of the memory buffer and onto the OUT unit when an SEDIT directive affecting another record is input.

The field specification **first,last** is lost after one manipulation. Subsequent string operations must specify the character positions based on the new configuration. For example, for the character string ACDEGbb in positions 1 through 7, addition of the character B in position 2 requires the field specification (2,7). Then, to add the character F between E and G, one must specify the field (6,7) rather than (5,7) because of the shift previously caused by insertion of the character B.

Example: Change the erroneous DAS MR source-statement operand in character positions 16-21 of the 32nd record from LOCXbb to LOC,Xb.

```
SA,32,(19,20),','
```

8.2.4 REPL (Replace Records) Directive

This directive replaces one sequence of source records with another sequence of records. It has the general form

REPL,recno1,*recno2*

where

recno1 is the number of the first record to be replaced

recno2 is the number of the last record to be replaced

If *recno2* is omitted, it is assumed equal to **recno1**, i.e., one record will be replaced.

The REPL directive copies source records from the IN logical unit onto the OUT logical unit beginning with the current position of the IN unit and continuing up to but *not* including the record specified by **recno1**. Then, records are read from IN, but not copied onto OUT, up to and including the record specified by *recno2*. Thus, the records **recno1** through *recno2*, inclusive, are deleted. Then, source records are copied from the ALT logical unit from the current position of the unit up to but *not* including the next end-of-file mark.

Example: Copy records from IN onto OUT from the current position of IN up to and including record 9. Replace IN records 10 through 20, inclusive, with records on ALT, copying those between the current position of ALT and the next end-of-file mark onto OUT. Do not copy the end-of-file mark.

```
REPL,10,20
```

8.2.5 SR (Replace String) Directive

This directive replaces one character string within a source record with another character string. It has the general form

SR,recno,(n1,n2,n3),'string'

where

recno is the number of the source record in which the character string is to be replaced

n1 is the number of the first character position of the string to be replaced

n2 is the number of the last character position of the string to be replaced

n3 is the number of the last character position of the field in which the string to be replaced occurs

string is the string of characters to be inserted in the field delimited by character positions **n1** and **n3** in record number **recno** after shifting out the characters in positions **n1** through **n2**, inclusive

The SR directive copies source records from the IN logical unit onto the OUT logical unit beginning with the current position of the IN unit and continuing up to but *not* including the record specified by **recno**. The record **recno** is read into the memory buffer. Field **n1,n3** is then shifted to the left and filled with blanks until the field **n1,n2** is shifted out. Then, the character string **string** shifts into the left end of the field **n1,n3**. There is no check on the length of **string** and shifting continues until it is left-justified in the field **n1,n3** with excess characters, if any, being truncated on the right.

The record remains in the memory buffer, thus permitting multiple string operations on the same record. (If IN is already positioned at **recno** because of a previous string operation, there is, of course, no change in position.)

The record **recno** is read out of the memory buffer and onto the OUT unit when a SEDIT directive affecting another record is input.

The field specification **n1,n2,n3** is lost after one manipulation. Subsequent string operations must specify the character positions based on the new configuration.

Example: Copy records from IN onto OUT up to and including record 49, and replace the present contents of character positions 10 through 12, inclusive, in IN unit source record 50 with the character string XYb.

```
SR,50,(10,12,12),'XY '
```

8.2.6 DE (Delete Records) Directive

This directive deletes a sequence of source records. It has the general form

DE,recno1,*recno2*

where

recno1 is the number of the first record to be deleted

recno2 is the number of the last record to be deleted

If *recno2* is omitted, it is assumed equal to **recno1**, i.e., one record will be deleted.

The DE directive processing is exactly like that of the REPL directive (section 8.2.4) except that there is no copying from the ALT unit after the deletion of the records **recno1** through *recno2*, inclusive.

Examples: Copy records from IN onto the OUT logical unit up to and including record 49, but delete records 50 through 54, inclusive.

```
DE,50,54
```

Position IN at record 2, deleting record 1.

```
DE,1
```

8.2.7 SD (Delete String) Directive

This directive deletes a character string from a source record. It has the general form

SD,recno,(n1,n2,n3)

where

recno is the number of the source record from which the character string is to be deleted

n1 is the number of the first character position of the string to be deleted

n2 is the number of the last character position of the string to be deleted

n3 is the number of the last character position of the field in which the string to be deleted occurs

The SD directive processing is exactly like that of the SR directive (section 8.2.5) except that no new character string is shifted into field n2,n3 after the field n1,n2 is shifted out.

Example: Copy records from IN onto OUT up to and including record 99, and delete characters 2 through 4, inclusive, from record 100, shifting characters 5 through 10, inclusive, three places to the left, with blank fill on the right.

```
SD,100,(2,4,10)
```

8.2.8 MO (Move Records) Directive

This directive moves a block of records forward on a unit. It has the general form

MO,recno1,*recno2***,recno3**

where

recno1 is the number of the first record to be moved

recno2 is the number of the last record to be moved

recno3 is the number of the record after which the block of records delimited by **recno1** and *recno2* is to be inserted

If *recno2* is omitted, it is assumed equal to **recno1**, i.e., one record will be moved.

The MO directive copies source records from the IN logical unit onto the OUT logical unit beginning with the current position of the IN unit and continuing up to but *not* including the record specified by **recno1**. The records **recno1** through *recno2* are then read into a special MOVE area in memory. The position of IN is now *recno2* + 1. When OUT reaches (by some succeeding directive) **recno3** + 1, the contents of the MOVE area are copied onto OUT. Multiple MO operations are legal.

Example: Copy records from IN onto OUT up to and including record 4, save records 5 through 10, inclusive, in the MOVE area of memory, copy records 11 through 99, inclusive, from IN onto OUT, and then copy records 5 through 10 from the MOVE area to OUT. This gives a record sequence on OUT of 1-4, 11-99, 5-10 (FC directive, section 8.2.9.).

```
MO,5,10,99
FC
```

8.2.9 FC (Copy File) Directive

This directive copies blocks of files, including end-of-file marks. It has the general form

FC,*nfiles*

where *nfiles* (default value = 1) is the number of files to be copied.

If the IN logical unit and/or the OUT logical unit is an RMD partition, *nfiles* must be 1 or absent. If OUT is a named file on an RMD, there will be an automatic close/update. Whenever an end-of-file mark is encountered, all record counters are reset to zero.

Examples: Copy files from IN onto OUT up to and including the next end-of-file mark on the IN unit.

```
FC
```

Copy the next six IN files (including end-of-file marks) onto OUT. This includes the sixth end-of-file mark. (Note: If IN and/or OUT is an RMD partition, there will be an error.)

```
FC,6
```

8.2.10 SE (Sequence Records) Directive

This directive assigns a decimal sequence number to each source record output to the OUT logical unit. It has the general form

SE,*(first,last),initial,increment*

where

first is the first character position of the sequence name field

last is the last character position of the sequence number field, where the default value of *first,last* is 76,80

initial is the initial number to be used as a sequence number (default value = 10)

increment is the increment to be used between successive sequence numbers (default value = 10)

There is also a special form of the SE directive to stop sequencing:

SE,N

where there are no parameters other than the letter N.

Examples: In the next record output to OUT, place 00010 in character positions 76 through 80, and increment the field by 10 in each succeeding record.

```
SE
```

In the next record output to OUT, place 030 in character positions 15 through 17, and increment the field by 7 on each succeeding record.

```
SE,(15,17),30,7
```

Stop sequencing.

```
SE,N
```

8.2.11 LI (List Records) Directive

This directive lists, on the LO logical unit, the records copied onto the OUT unit. The LI directive has the general form

LI,*list*

where *list* is A (default value) if all OUT records are to be listed, C if only changed records are to be listed, or N if listing is to be suppressed. Source records output to the OUT file are listed with their OUT record number at the left of the print list.

Examples: List all records output to OUT.

```
LI
```

Suppress all listing except that of SEDIT directives.

```
LI,N
```

8.2.12 GA (Gang-Load All Records) Directive

This directive loads the same character string into the specified field of every record copied onto the OUT logical unit. It has the general form

GA,*(first,last)*,'string'

where

first is the first character position of the field to be gang-loaded

last is the last character position of the field to be gang-loaded, where the default value of *first,last* is 73,75

string is the string of characters to be gang-loaded into character positions *first* through *last*, inclusive in all records copied onto out

There is also a special form of the GA directive to stop gang-loading:

GA

where there are no parameters in the directive.

In every OUT record, GA clears the specified field, and loads the string into it. There is no check on the length of string and shifting continues until it is left-justified in the specified field with excess characters, if any, being truncated on the right.

Examples: Load character string VDMbb in character positions 11 through 15, inclusive, of every record copied onto OUT.

```
GA,(11,15),'VDM  '
```

Stop gang-loading.

```
GA
```

8.2.13 WE (Write End of File) Directive

This directive writes an end-of-file mark on the OUT logical unit. It has the form

WE

without parameters. If OUT is a named file on an RMD, there will be an automatic close/update.

Example: Write an end-of-file mark on OUT, a magnetic-tape unit.

```
WE
```

8.2.14 REWI (Rewind) Directive

This directive rewinds the specified SEDIT logical unit(s). It has the general form

REWI,p(1),*p(2),p(3)*

where each **p(n)** is a name of one of the SEDIT logical units: IN, OUT, or ALT. These can be coded in any order.

Example: Rewind all SEDIT logical units.

```
REWI,IN,ALT,OUT
```

8.2.15 CO (Compare Inputs) Directive

This directive compares the specified field in the inputs from the IN logical unit with those from the ALT logical unit and lists discrepancies on the LO logical unit. The directive has the general form

CO,*(first,last),limit*

where

first is the first character position of the field to be compared

last is the last character position of the field to be compared, where the default value of *first,last* is 1,80.

limit is the maximum number of discrepancies to be listed before aborting the comparison and passing to the next directive.

Any discrepancy between the IN and ALT inputs is listed in the format

```
I recordnumber or EOF inrecord
A recordnumber or EOF altrecord
```

If the comparison terminates by reaching the *limit* number of discrepancies, SEDIT outputs on the LO the message

```
SEDIT COMPARE ABORTED
```

to prevent long listings of errors, for example, where a card is misplaced or missing on one input. A normal termination of a comparison (at the next end-of-file mark) concludes with the message

```
SEDIT COMPARE FINISHED
```

Example: Compare character positions 1 through 80, inclusive, from the IN and ALT units until either an end of file is found or there have been 5 discrepancies listed on the LO.

```
CO,,5
```

8.3 EXAMPLE OF EDITING A FILE

Following is a sample job stream for editing an existing file on a magnetic tape onto a new file on magnetic tape. The input file consists of 80-character records followed by an end-of-file mark. The job stream and the edit cards are read through the system input device.

```
/JOB,EDIT
/ASSIGN,PI=MT00,PO=MT10
/REW,PI,PO
/SEDIT
AS,IN=PI
AS,OUT=PO
AS,ALT=SI
DE,5
REPL,8,10
        LDA   TEMP
(EOF card, 2-7-8-9 punch)
ADD,17
TBL     BSS   5
(EOF card, 2-7-8-9 punch)
FC
REWI,IN,OUT
/ENDJOB
```

The result of running the preceding source editor example would be the following:

Input File

```
 1 *
 2 *        CATALOG ROUTINE
 3 *
 4 A$3      EQU     6
 5 B$3      EQU     9
 6 *
 7 CATLOG   DATA    0
 8          LDA     TMX
 9          LDB     TMY
10          JBZM    ODER
11          ADD     PARM6
12          ANAI    0770
13          STA     TBL+2
14          LRLA    6
15          STA     TBL+4
16          TZB
17          JMP*    CATLOG
```

Output File

```
 1 *
 2 *        CATALOG ROUTINE
 3 *
 4 A$3      EQU     6
 5 *
 6 CATLOG   DATA    0
 7          LDA     TEMP
 8          ADD     PARM6
 9          ANAI    0770
10          STA     TBL+2
11          LRLA    6
12          STA     TBL+4
13          TZB
14          JMP*    CATLOG
15 TBL      BSS     5
```

SECTION 9
FILE MAINTENANCE

The VORTEX **file-maintenance component (FMAIN)** is a background task that manages file-name directories and the space allocations of the files. It is scheduled by the job-control processor (JCP) upon input of the JCP directive /FMAIN (section 4.2.18).

Only files assigned to rotating-memory devices (disc or drum) can be referenced by name.

File space is allocated within a partition forward in contiguous sectors of the same cylinder, skipping bad tracks. The only exception to this continuity is the file-name directory itself, which is a sequence of linked sectors that may or may not be contiguous.

9.1 ORGANIZATION

FMAIN inputs file-maintenance directives (section 9.2) received on the SI logical unit and outputs them on the LO logical unit and on the SO logical unit if it is a different physical device from the LO unit. Each directive is completely processed before the next is input to the JCP buffer.

If the SI logical unit is a Teletype or a CRT device, the message **FM**** is output on it before input to indicate that the SI unit is waiting for FMAIN input.
If there is an error, one of the error messages given in Appendix A.9 is output on the SO logical unit, and a record is input from the SO unit to the JCP buffer. If the first character of this record is /, FMAIN exits via the EXIT macro. If the first character is C, FMAIN continues. If the first character is neither / nor C, the record is processed as a normal FMAIN directive. FMAIN continues to input and process records until one whose first character is / is detected, when FMAIN exits via exit. (An entry beginning with a carriage return is an exception to this, being processed as an FMAIN directive).

FMAIN has a symbol-table area for 200 symbols at five words per symbol. To increase this area, input a /MEM directive (section 4.2.5), where each 512-word block will enlarge the capacity of the table by 100 symbols.

9.1.1 Partition Specification Table

Each rotating-memory device (RMD) is divided into up to 20 memory areas called **partitions**. Each partition is referenced by a specific logical-unit number. The boundaries of each partition are recorded in the core-resident **partition specification table (PST)**. The first word of the PST contains the number of VORTEX physical records per track. The second word of the PST contains the address of the bad-track table, if any. Subsequent words in the PST comprise the four-word partition entries. Each PST is in the format:

Bit	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0		
Word 0	Size of bad track table (120-words)		
Word 1	Address of bad track table (0 if none) relative to word 0		
Word 0	Beginning partition track address		
Word 1	PPB	Not used	Protection code
Word 2	Number of bad tracks in partition		
Word 3	Ending partition address + 1		
	• • •		

The partition protection bit, designated ppb in the above PST entry map, is unused in file maintenance procedures.

Note that PST entries overlap. Thus, word 3 of each PST entry is also word 0 of the following entry. The relative position of each PST entry is recorded in the **device specification table (DST)** for that partition.

The **bad-track table**, whose address is in the second word of the PST, is a bit string read from left to right within each word, and forward through contiguous words, with set bits flagging bad tracks on the RMD. (If there is no bad-track table, the second word of the PST contains zero.)

9.1.2 File-Name Directory

Each RMD partition contains a **file-name directory** of the files contained in that partition. The beginning of the directory is in the first sector of the partition. The directory for each partition has a variable number of entries arranged in n sectors, 19 entries per sector. Sectors containing directory information are chained by pointers in the last word of each sector Thus, directory sectors need not be contiguous Each directory entry is in the format:

Bit	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Word 0	File name
Word 1	File name
Word 2	File name
Word 3	Current position of file
Word 4	Beginning file address
Word 5	Ending file address

The file name comprises six ASCII characters packed two characters per word, left justified, with blank fill Word 3, which contains the current address at which the file is positioned, is initially set to the ending file address, and is manipulated by I/O control macros (section 3). The extent of the file is defined by the addresses set in words 4 and 5 when the file is created, and remains constant.

The first sector of each partition is assigned to the file-name directory. FMAIN allocates RMD space forward in contiguous sectors, skipping bad tracks. Following the last entry in each directory sector is a one-word tag containing either the value 01 (end of directory), or the address of the next sector of the file-name directory.

The file-name directories are created and maintained by the file-maintenance component for the use of the I/O control component (section 3). User access to the directories is via the I/O control component.

Special entries: A **blank entry** is created when a file name is deleted, in which case the file name is ****** and words 3 through 5 give the extent of the blank file. A **zero entry** is created when one name of a multiname file is deleted, in which case the deleted name is converted to a *blank entry* and all other names of the multiname file are set to zero.

WARNING

To prevent possible loss of data from the file-name directory during file-maintenance operations, FMAIN sets the **lock bit** (bit 12 of word 2 of the DST) before any directory operation, thus inhibiting all foreground requests for I/O with the partition being modified. Upon completion of the directory operation, FMAIN clears the lock bit. Except for the use of protection codes, **this is the only protection for the file-name directory**. Manipulation of foreground files with FMAIN is at the user's risk. For example, VORTEX does not prevent deletion of a file name from a file-name directory that has been opened and is being written into by a foreground program. Therefore, foreground files should be reassigned prior to manipulation by FMAIN.

9.1.3 Relocatable Object Modules

Outputs from both the DAS MR assembler and the FORTRAN compiler are in the form of relocatable object modules. Relocatable object modules can reside on any VORTEX-system logical unit. Before object modules can be read from a unit by the FMAIN INPUT and ADD directives (sections 9.2.7 and 9.2.8), an I/O OPEN with rewinding (section 3.5.1) is performed on the logical unit, i.e., the unit (except paper-tape or card readers) is first positioned to the beginning of device or load point for that unit. Object modules can then be loaded until an end-of-file mark is found.

The system generator (section 15) does not build any object-module library. FMAIN is the only VORTEX component used for constructing user object-module libraries.

A VORTEX physical record on an RMD is 120 words. Object-module records are blocked two 60-word records per VORTEX physical record However, in the case of an RMD assigned as the SI logical unit, object modules are not blocked but assumed to be one object-module record per physical record.

9.1.4 Output Listings

FMAIN outputs four types of listing to the LO logical unit:

- **Directive listing** lists, without modification, all FMAIN directives entered from the SI logical unit.
- **Directory listing** lists file names from a logical unit file-name directory in response to the FMAIN directive LIST (section 9.2.5).
- **Deletion listing** lists file names deleted from a logical unit file-name directory in response to the FMAIN directive DELETE (section 9.2.2).
- **Object-module listing** lists the object-module input in response to the FMAIN directive ADD (section 9.2.8).

All FMAIN listings begin with the standard VORTEX heading.

The *directory listing* is further described under the discussion of FMAIN directive LIST (section 9.2.5), the *deletion listing* under DELETE (section 9.2.2), and the *object-module listing* under ADD (section 9.2.8).

9.2 FILE-MAINTENANCE DIRECTIVES

This section describes the file-maintenance directives:

- CREATE file
- DELETE file
- RENAME file
- ENTER new file name
- LIST file names
- INIT (initialize) directory
- INPUT logical unit for object module
- ADD object module

File-maintenance directives comprise sequences of character strings having no embedded blanks. The character strings are separated by commas (,) or by equal signs (=). The directives are free-form and blanks are permitted between the individual character strings of the directive, i.e., before or after commas (or equal signs). Although not required, a period (.) is a line terminator. Comments can be inserted after the period.

The general form of a file-maintenance directive is

directive,lun,*p(1),p(2),...,p(n)*

where

directive is one of the directives listed above in capital letters

lun is the number or name of the affected logical unit

each *p(n)* is a parameter defined under the descriptions of the individual directives below

Numerical data can be octal or decimal. Each octal number has a leading zero.

For greater clarity in the descriptions of the directives, optional periods, optional blank separators between character strings, and the optional replacement of commas (,) by equal signs (=) are omitted.

Error messages applicable to file-maintenance directives are given in Appendix A.9.

9.2.1 CREATE Directive

This directive creates a new file on the specified logical unit, allocates RMD space to the file, adds a corresponding entry to the file-name directory, and sets the current end-of-file value to one greater than the address of the last sector assigned to the new file.

The directive has the general form

CREATE,lun,*key***,name,words,records**

where

lun is the number or name of the logical unit where the new file is to be created

key is the protection code, if any, required to address **lun**

name is the name of the file being created

words is the number of words in each record of the file

records is the number of records in the file

Size parameters merely allocate space for the file and do not limit file use to the specified record size. To each record in the created file, FMAIN assigns n records of 120 words each where n is the smallest integer such that **words**/120 is less than or equal to n. The file size is n times **records** words. This value is converted to a sector count to make assignments. Neither the file size value nor the sector count value is saved.

Example: Create the file XFILE with ten records of 120 words each on logical unit 112, whose protection code is K.

```
CREATE,112,K,XFILE,120,10
```

9.2.2 DELETE Directive

This directive deletes the designated file and all file-name directory references to it from the specified logical unit. It converts the specified file-name directory entry to a blank entry (name field = ******, section 9.1.2) and all other directory references to this file to zero entries (all fields = zero, section 9.1.2), and outputs a listing of deleted file-names on the LO logical unit. The directive has the general form

DELETE,lun,*key***,name**

where

lun is the number or name of the logical unit from which the file is being deleted

key is the protection code, if any, required to address **lun**

name is the name of the file being deleted (in the case of a multiname file, any one of the names can be used, all names are deleted)

The output format has, following the FMAIN heading, a two-line heading

```
DELETE LISTING FOR lun
FILE NAME    START    END    CURRENT
```

where lun is the number of the logical unit from which the file is being deleted. This heading is followed by a blank line and a listing of all file-names being deleted, one per line. Words 0-2 of the file-name directory entry (section 9.1.2) are placed in the FILE NAME column; word 3, (in octal) in the CURRENT column; word 4, (in octal) in the START column; and word 5, (in octal) in the END column. After the last file name, there is an entry describing the blank file created by the deletion, where the FILE NAME column contains ******, the START column contains the next available address (word 2 of the PST entry), and both the CURRENT and END columns contain the last address + 1 (word 3 of the PST entry).

Example: Delete the file ZFILE (and all file-name directory entries referencing it) from logical unit 112, whose protection code is P).

```
DELETE,112,P,ZFILE
```

The name ZFILE is replaced in the file-name directory by ******, and the space allocation for this blank entry extended in both directions to include adjacent blank entries, if any. Any blank entries thus absorbed are converted to zero entries, as are all other entries that reference the file ZFILE. All affected file-name directory entries are listed on the LO logical unit.

9.2.3 RENAME Directive

This directive changes the name of a file, but does not otherwise modify the file-name directory. The directive has the general form

RENAME,lun,*key*,old,new

where

lun is the number or name of the logical unit where the file to be renamed is located

key is the protection code, if any, required to address **lun**

old is the old name of the file being renamed

new is the new name of the file being renamed

Following RENAME, **old** can no longer be used to reference the file.

Example: On logical unit 112, whose protection code is P, change the name of the file XFILE to YFILE.

```
RENAME,112,P,XFILE,YFILE
```

9.2.4 ENTER Directive

This directive adds a new file name to be used in referencing an existing file, but does not otherwise modify the file-name directory. ENTER thus permits multiname access to a file. The directive has the general form

ENTER,lun,*key*,old,new

where

lun is the number or name of the logical unit where the affected file is located

key is the protection code, if any, required to address **lun**

old is an old name of the affected file

new is the new name by which the file can also be referenced

Example: On logical unit 113, whose protection code is K, make the file X1 accessible by using either the name X1 or the name Y1.

```
ENTER,113,K,X1,Y1
```

9.2.5 LIST Directive

This directive outputs on the LO logical unit the file-name directory of the specified logical unit. The output comprises the file names, file extents, current end-of-file positions, logical-unit name or number, and the extent of unassigned space in the partition. All numbers are in octal. The directive has the general form

LIST,lun,*key*

where

lun is the number or name of the logical unit whose contents are to be listed

key is the protection code, if any, required to address **lun**

The output format has a two-line heading

```
FILE DIRECTORY FOR LUN lun
FILE NAME       START      END        CURRENT
```

where lun is the number or name of the logical unit whose contents are being listed. This heading is followed by a blank line and a listing of all file names from the directory, one name per line. Words 0-2 of the file-name directory entry (section 9.1.2) are placed in the FILE NAME column; word 4, (in octal) in the START column; word 3, (in octal) in the CURRENT column; and word 5, (in octal) in the END column. After the last file name, if there is any unassigned space in the partition, there is an entry describing the unassigned space in the partition, where the FILE NAME column contains *UNAS*, the START column contains the next available address, and both the CURRENT and END columns contains the last address + 1. All numerical values are octal sectors.

Example: List the file-name directory of logical unit 114, which has no protection code.

```
LIST,114
```

9.2.6 INIT (Initialize) Directive

This directive clears the entire file-name directory of the specified logical unit, deletes all file names in it, and releases all currently allocated file space in the partition by reducing the file-name directory to a single end-of-directory entry. The directive has the general form

INIT,lun,*key*

where

lun is the number or name of the logical unit being initialized

key is the protection code, if any, required to address **lun**

Example: Initialize the file-name directory on logical uni 115, which has protection code X.

```
INIT,115,X
```

9.2.7 INPUT Directive

This directive specifies the logical unit from which object modules are to be input. Once specified, the input logical-unit number is constant until changed by a subsequent INPUT directive. The directive has the general form

INPUT,lun,*key*,*file*

where

lun is the number or name of the logical unit from which object modules are to be input

key is the protection code, if any, required to address **lun**

file is the name of the RMD file containing the required object module(s)

Neither *key* nor *file* are required unless **lun** is a RMD partition.

NOTE

There is no default value. Thus, if an attempt is made to input an object module (ADD directive, section 9.2.8) without defining the input logical unit by an INPUT directive, an error message will be output.

Examples: Specify logical unit 6 as the device from which object modules are to be input.

```
INPUT,6
```

Open and rewind the file ARCTAN on logical unit 104, which has protection code D.

```
INPUT,104,D,ARCTAN
```

9.2.8 ADD Directive

This directive reads object modules from the INPUT unit (section 9.2.7) and writes them onto the SW logical unit, checking for entry names and validating check-sums, record sizes, loader codes, sequence numbers, and record structures. Reading continues until an end of file is encountered. Entry names are then added to the file-name directory of the specified logical unit and the object modules are copied from the SW logical unit onto the specified logical unit. The directive has the general form

ADD,lun,*key*

where

lun is the number or name of the logical unit onto which object modules are to be written

key is the protection code, if any, required to address **lun**

The specified logical unit **lun** references a system or user object-module library.

The names of the object modules and their date of generation, size in words (zero for FORTRAN modules), entry names, and referenced external names are listed on the LO logical unit.

To recover from errors in object-module-processing, reposition the logical unit to the beginning of the module.

Example: Add object modules to logical unit 104, which has protection code D.

```
ADD,104,D
```

9.3 VORTEX FOREGROUND FILE MAINTENANCE (V$FGFM)

The VORTEX Foreground File Maintenance program provides a subset of the VORTEX FMAIN services. V$FGFM executes as an independent task from the VORTEX foreground library at the same priority as the calling task. The interface to V$FGFM is the subroutines, V$FILE, which must be in the Object Module Library and V$FMCB which must be resident in the nucleus table area (this occurs automatically during system generation unless modules are specifically deleted).

The calling sequence to request a file service is as follows:

```
EXT     V$FILE
LDAI    code
LDBI    fmcb
JSR     V$FILE,X
```

where

code is the operation code for the requested service

0 = create
1 = delete
2 = rename

3 = enter
4 = unused (RL [illegible]

fmcb is the address of the file maintenance control block (see table)

The create, delete, rename and enter requests perform the same operations as in the VORTEX FMAIN program. The unused request releases the unused portion of the named file which is that area of the file beyond the current end-of-file.

Upon exit from a file request the A register contains the completion status code. The interface program allows only one file request to be processed at a time. If upon entry a previous request is being processed (V$FMCB is busy), V$FILE executes a 500 millisecond DELAY and tries again. If ater 15 seconds (30 retries) V$FMCB is still busy V$FILE will proceed to schedule V$FGFM and process the new request. The completion status codes are as follows:

-1	busy
0	request completed without error
1	invalid request code
2	name already in directory
3	name not found
4	unsufficient space
5	input/output error occurred
6	directory structure error

The file maintenance control blocks for the requests must be arranged as follows:

Word	Create	Delete Unused	Rename Enter
0	logical unit	logical unit	logical unit
1	key	key	key
2	file name	file name	current file name
3			
4			
5	number of sectors		new file name
6			
7			

SECTION 10
INPUT/OUTPUT UTILITY PROGRAM

The I/O utility program (IOUTIL) is a background task for copying records and files from one device onto another, changing the size and mode of records, manipulating files and records, and formatting the records for printing or display.

10.1 ORGANIZATION

IOUTIL is scheduled for execution by inputting JCP directive /IOUTIL (section 4.2.20) on the SI logical unit. If the SI logical unit is a Teletype or a CRT device, the message IU** is output to indicate that the SI unit is waiting for IOUTIL input. Once activated, IOUTIL inputs and executes directives from the SI unit until another JCP directive (first character is a slash) is input, at which time IOUTIL terminates and the JCP is again scheduled.

"The IOUTIL buffer is usually 1024 words long. The /MEM directive can be used to increase this size by increments of 512 words."

IOUTIL has the option of calling V$RSW (multi-volume reel-switch routine), when using a copy file, copy record, skip file, skip record, format and dump, position file, and pack binary.

Error Messages applicable to IOUTIL are given in Appendix A.10. Recovery from an error is by either of the following:

a. Input the character C on the SO unit, thus directing IOUTIL to go to the SI unit for the next directive.

b. Input the corrected directive on the SO unit for processing. The next IOUTIL directive is then input from the SI unit.

If recovery is not desired, input a JCP directive (section 4.2) on the SO unit to abort IOUTIL and schedule the JCP for execution..

10.2 I/O UTILITY DIRECTIVES

This section describes the IOUTIL directives:

•	COPYF	Copy file
•	COPYR	Copy record
•	SFILE	Skip file
•	SREC	Skip record
•	DUMP	Format and dump
•	PRNTF	Print file
•	WEOF	Write end of file
•	REW	Rewind
•	PFILE	Position file
•	CFILE	Close file
•	PACKB	Pack binary

IOUTIL directives begin in column 1 and comprise sequences of character strings having no embedded blanks. The character strings are separated by commas (,) or by equal signs (=). The directives are free-form and blanks are permitted between individual character strings of the directive, i.e., before or after commas (or equal signs). Although not required, a period (.) is a line terminator. Comments can be inserted after the period

The general form of an IOUTIL directive is

name,*p(1)*,*p(2)*,...,*p(n)*

where

name is one of the directive names given above

each *p(n)* is a parameter defined below under the descriptions of the individual directives

Numerical data can be octal or decimal. Each octal number has a leading zero.

For greater clarity in the descriptions of the directives, optional periods, optional blank separators between character strings, and the optional replacement of commas (,) by equal signs (=) are omitted.

The IOUTIL buffer is usually 1024 words long. The /MEM directive can be used to increase this size by increments of 512 words.

10.2.1 COPYF (Copy File) Directive

This directive copies the specified number of files from the indicated input logical unit to the given output logical unit(s). The directive has the general form

COPYF,f,iu,im,irl,ou(1),om,orl,*ou(2)*,*ou(3)*,...,*ou(n)*

where

f is the number of input files to be copied (must be 1 for RMD)

iu is the name or number of the input logical unit

im is 0 for binary, 1 for ASCII, 2 for BCD or 3 for unformatted input files

irl is the number of words in each record of the input files. If a value of zero is specified then the record length is set to the maximum buffer size. Following the read the actual physical record length (word 5 of the RQBLK) is used as the input record length.

ou(n) is the name or number of an output logical unit

om is 0 for binary, 1 for ASCII, 2 for BCD, or 3 for unformatted output files

orl is the number of words in each record of the output files. If a value of zero is specified then the output record length is equal to the input record length.

Any RMD involved with copying files, whether as input or output medium, must have been previously positioned with a PFILE directive (section 10.2.9).

If a difference in record lengths irl and orl causes a partial record to remain when an end of file is encountered, the part-record is filled with blanks and thus transmitted to the output unit(s).

The following relation holds for input/output record lengths:

Input RCL	Output RCL	Output Format
fixed	fixed	As defined (blocked or unblocked)
random (0)	fixed	As defined (blocked or unblocked)
fixed	random (0)	Unblocked only
random (0)	random (0)	Unblocked only

Record lengths of zero are useful in copying mixed ASCII and binary data from cards to another media or vise versa. ASCII read must be specified for this operation.

Example: Copy three files containing 120-word records from the PI logical unit onto logical units LO, 50, and 51 in 40-word records.

```
COPYF,3,PI,1,120,LO,1,40,50,51
```

10.2.2 COPYR (Copy Record) Directive

This directive copies the specified number of records from the indicated input logical unit to the given output logical unit(s). The directive has the general form

COPYR,r,iu,im,irl,ou(1),om,orl,*ou(2),ou(3),...,ou(n)*

where

r is the number of input records to be copied, or 0 if copying is to continue to the end of file

iu is the name or number of the input logical unit

im is 0 for binary, 1 for ASCII, 2 for BCD, or 3 for unformatted input records

irl is the number of words in each record of the input files. If a value of zero is specified then the record length is set to the maximum buffer size. Following the read the actual physical record length (word 5 of the RQBLK) is used as the input record length.

each ou(n) is the name or number of an output logical unit

om is 0 for binary, 1 for ASCII, 2 for BCD, or 3 for unformatted output records

orl is the number of words in each record of the output files. If a value of zero is specified then the output record length is equal to the input record length.

Any RMD involved with copying records, whether as input or output medium, must have been previously positioned with a PFILE directive (section 10.2.9).

If a difference in record lengths irl and orl causes a part-record to remain when an end-of-file mark is encountered, the part-record is filled with blanks and thus transmitted to the output unit(s).

Example: Copy 25 unformatted records of 200 words each from the SS logical unit to the BO and PO units in binary format with 40 words per record.

```
COPYR,25,SS,3,200,BO,0,40,PO
```

It may be necessary to copy from one file on an RMD partition to another file on the same partition. This can be accomplished by assigning two *different* logical units to this RMD partition, and then issuing two PFILE directives (section 10.2.9), positioning one logical unit to the beginning of one file and the second logical unit to the beginning of the other file. Additional positioning within the files can be specified by SREC directives (section 10.2.4).

The following relation holds for input/output record lengths:

Input RCL	Output RCL	Output Format
fixed	fixed	As defined (blocked or unblocked)
random (0)	fixed	As defined (blocked or unblocked)

Input RCL	Output RCL	Output Format
fixed	random (0)	Unblocked only
random (0)	random (0)	Unblocked only

Record lengths of zero are useful in copying mixed ASCII and binary data from cards to another media or vise versa. ASCII read must be specified for this operation.

Example: Copy the first ten records from file EDIT1 to record 11 through 20 of file EDIT2. Both files are on RMD partition D00K, have record lengths of 120 words, are in mode 1, and have no protection key (default value = 0). Assign the BI and BO logical units to the disc.

```
/ASSIGN,BI=D00K
/ASSIGN,BO=D00K
/IOUTIL
PFILE,BI,,120,EDIT1
PFILE,BO,,120,EDIT2
SREC,BO,10
COPYR,10,BI,1,120,BO,1,120
```

10.2.3 SFILE (Skip File) Directive

This directive, which applies only to magnetic-tape units, and card readers, causes the specified logical unit to move the tape *forward* the designated number of end-of-file marks. The directive has the general form

SFILE,lun,neof

where

lun is the name or number of the affected logical unit

neof is the number of end-of-file marks to be skipped

If the end-of-tape mark is encountered before the required number of files has been skipped, IOUTIL outputs to the SO and LO logical units the error message **IU05,nn**, where nn is the number of files remaining to be skipped.

Example: Move tape on unit PI past three end-of-file marks.

```
SFILE,PI,3
```

10.2.4 SREC (Skip Record) Directive

This directive, which applies only to magnetic-tape units, card readers and RMDs, causes the specified logical unit to skip *forward* the designated number of records. The directive has the general form

SREC,lun,nrec

where

lun is the name or number of the affected logical unit

nrec is the number of records to be skipped

Note that, unlike JCP directive /SREC (section 4.2.8), the IOUTIL directive SREC cannot skip records in reverse.

If **lun** designates an RMD partition, the device must have been previously positioned with a PFILE directive (section 10.2.9).

If a file mark, an end-of-tape mark, or an end-of-device mark is encountered before the required number of records has been skipped, IOUTIL outputs to the SO and LO logical units the error message **IU05,nn**, where **nn** is the number of records remaining to be skipped.

Example: Skip 40 records on the BI logical unit.

```
SREC,BI,40
```

10.2.5 DUMP (Format and Dump) Directive

This directive copies the specified number of records from the indicated input logical unit, formats them for listing, and dumps the data onto the output unit in octal format, ten words per line, with one blank between words. The directive has the general form

DUMP,r,iu,im,irl,ou

where

r is the number of input records to be dumped or is zero if dumping is to continue to an end-of-file

iu is the name or number of the input logical unit

im is 0 for binary, 1 for ASCII, 2 for BCD, or 3 for unformatted input records

irl is the number of words in each record of the input

ou is the name or number of the output unit, which cannot be an RMD partition

The first line of the dump contains the record number before word 1, but subsequent lines do not have the record number.

If ASCII mode is specified by im then an ASCII scan and dump will be made in addition to the octal dump. Printable character bytes will appear to the right of each line of the octal dump. Non-printable characters will appear as ASCII blanks. ASCII scan and dump is suppressed if dump is to a TY or CT device regardless of the mode.

Example: Dump 40 binary, 50-word records from the SW logical unit onto the LO unit.

```
DUMP,40,SW,0,50,LC
```

10.2.6 PRNTF (Print File) Directive

This directive prints the specified number of files from the indicated input logical unit to the list output logical unit(s) specified. The directive has the general form

PRNTF,f,iu,ou(1),*ou(2),...ou(n)*

where

f — is the number of files to be printed
iu — is the name or number of the input logical unit

each **ou(n)** — is the name or number of a list output logical unit

If an RMD is specified as the input logical unit, it must have been previously positioned with a PFILE directive (section 10.2.9) and only one file may be printed at a time (i.e., if it is greater than 1, it is defaulted to 1), because the end-of-file terminates printing.

This directive is designed to print list output files directed to devices other than a line printer (i.e., magnetic tape or disc). Therefore, the input file is read in ASCII mode (1), 132 characters, and the list output records are written also in ASCII mode.

Example: Print two (2) files on magnetic tape unit 18 on LO.

```
/IOUTIL
REW,18
PRNTF,2,18,LO
/ENDJOB
```

Example: Print an RMD file called SYSOUT in logical unit 25 to LO.

```
/IOUTIL
PFILE,25,,120,SYSOUT
PRNTF,1,PI,LO
/ENDJOB
```

10.2.7 WEOF (Write End of File) Directive

This directive writes an end-of-file mark on each logical unit specified. The directive has the general form

WEOF,lun,*lun,...,lun*

where each **lun** is the name or number of a logical unit upon which an end-of-file mark is to be written.

Example: Write an end-of-file mark on the BO logical unit and on the PO logical unit.

```
WEOF,BO,PO
```

10.2.8 REW (Rewind) Directive

This directive, which applies only to magnetic-tape units, causes the specified logical unit(s) to rewind to the beginning of tape. The directive has the general form

REW,lun,*lun,...,lun*

where each **lun** is the name or number of a logical unit to be rewound.

Example: Rewind the BI and PO logical units.

```
REW,BI,PO
```

10.2.9 PFILE (Position File) Directive

This directive, which applies only to rotating-memory devices, causes the specified logical unit to move to the beginning of the designated file, and opens the file. The directive has the general form

PFILE,lun,*key***,recl,name**

where

lun — is the name or number of the affected logical unit

key — is the protection code required to address **lun**

recl — is the number of words in each record of the file

name — is the name of the file to which the logical unit is to be positioned

Since IOUTIL has only six FCBs, there can be a maximum of six files open at any given time.

Example: Position the PI logical unit, using protection code Z, to the beginning of the file FILEXY, which contains 60-word records.

```
PFILE,PI,Z,60,FILEXY
```

10.2.10 CFILE (Close File) Directive

This directive, which applies only to RMD partitions, closes the specified file. The directive has the general form

CFILE,lun,*key*,name,*add*

where

lun is the name or number of the logical unit containing the file to be closed

key is the protection code required to address **lun**

name is the name of the file to be closed

add is 0 (default value) if the current end-of-file address on the RMD file-directory is to remain unchanged, or 1 if it is to be replaced by the current record (i.e., actual) address

A PFILE directive (section 10.2.9) must have been used to position **lun** before the CFILE directive is issued. Closing a file frees the associated FCB for use with another file. Since IOUTIL has only six FCBs, there can be a maximum of six files open at any given time.

Example: Close the file WORK on the SW logical unit (protection code B) and update the file directory.

```
CFILE,SW,B,WORK,1
```

10.2.11 PACKB (Pack Binary) Directive

This directive copies the specified number of files from the indicated input logical unit to the given output logical unit(s). It causes each new system binary program to start on a record boundary. The directive has the general form

PACKB,f,lu,im,irl,ou(1),om,orl,ou(2),...ou(n)

where

f is the number of input files to be copied

iu is the name or number of the input logical unit.

im is 0 for binary, 1 for ASCII, 2 for BCD, or 3 for unformatted input files.

irl is the number of words in each record of the input files. If a value of zero is specified then the record length is set to the maximum buffer size. Following the read the actual physical record length (word 5 of the RQBLK) is used as the input record length.

ou(n) is the name or number of an output logical unit.

om is 0 for binary, 1 for ASCII, 2 for BCD, or 3 for unformatted output files

orl is the number of words in each record of the output files. If a value of zero is specified then the output record length is equal to the input record length

The following relation holds for input/output record lengths:

Input RCL	Output RCL	Output Format
fixed	fixed	As defined (blocked or unblocked)
random (0)	fixed	As defined (blocked or unblocked)
fixed	*random (0)*	*Unblocked only*
random (0)	random (0)	Unblocked only

Any RMD used in this directive must have been previously positioned with a PFILE directive (section 10.2.9).

This directive can be used for any output media and any record length. It is primarily intended to be used for RMD output of 120 words. Use with non-RMD output may not produce the intended effect.

Example: Pack one binary file from the card reader onto a RMD file on logical unit 25 in 120 word blocks:

```
PACKB,1,CR,0,60,25,0,120
```

10.3 MULTI-VOLUME TAPE HANDLING (V$RSW)

IOUTIL provides the operator with interfaces necessary for handling multi volume (i.e., multi-reel), magnetic tape files. The routine directs the operator to unload the current magnetic tape volume and mount a new one whenever end-of-tape is encountered

The magnetic tape unit to be unloaded is given a rewind directive and the following message is output to the operator:

```
IOUTIL: UNLOAD LUN nn
IOUTIL: MOUNT NEXT VOLUME
```

where

nn   is the logical unit number of the magnetic tape to unload.

After the message for mounting a new magnetic tape has been output to the operator, the subroutine issues a suspend request. When the new volume has been successfully mounted, the operator can continue execution by keying in the following:

```
;RESUME, IOUTIL   '
```

If the mounting of a new magnetic tape volume is not needed, the operator will key in the message **;ABORT, IOUTIL** on the OC device, which will return control to JCP.

SECTION 11
VSORT (SORT/MERGE)

The VORTEX Sort/Merge (VSORT) task constructs a sorted file in the order determined by fields selected by the user.

11.1 ORGANIZATION

VSORT is scheduled as a background task by the Job-Control Processor (JCP, section 4.2.19) upon input of the JCP directive

```
/LOAD,VSORT
```

Once activated, VSORT inputs the sort parameters from the SI logical unit. The maximum number of VSORT directives is five records. The directive ENDSORT terminates the input of VSORT directives within five records. Upon completion of the sort/merge, VSORT exits to JCP.

VSORT has a buffer area large enough for most sort/merge operations. To increase the size of the buffer, input a /MEM directive (see section 4.2.3) immediately preceding the /LOAD,VSORT directive.

Inputs to VSORT comprise

a. VSORT directives (section 11.2) input through the SI logical unit

b. File to be sorted, input through the INPUT logical unit

Outputs from VSORT comprise

a. Sorted file on the OUTPUT logical unit

b. Listing of VSORT directives on the LO logical unit

c. Listing of VSORT totals for the sort/merge on the LO logical unit

d. Error messages, if any, on the LO logical unit

Error messages applicable to VSORT are given in Appendix A.11.

VSORT performs either a full-record sort or a tag sort. In a full-record sort the entire records are moved in central memory in order to accomplish the sort. In a tag sort, only the concatenated sorting control fields and the record numbers are manipulated in central memory. VSORT will perform the more efficient tag sort unless one of the following conditions occurs:

a. INPUT file is not an RMD

b. The file used for INPUT is also used for another file in the sort, either as a WORK or OUTPUT file

c. A user input exit routine is specified (by the INEXIT directive)

Workspace Requirements: Each work file must be large enough to contain a number of work records equal to the number of input records. For tag sorts, the length of the work records is equal to the sum of the length of the control fields plus one word. On full-record sorts, the sum of the control fields plus one input record length is needed.

Work records are blocked with a blocksize equal to a fourth or third of the central memory workspace for the merge phase.

Work space for the sort phase in central memory is allocated dynamically to overlay the initialization routine (about 2K), which occupies the highest memory locations of VSORT. Work space for the merge phase occupies an additional 1K in central memory. Additional work space may be allocated for a background sort by using the /MEM directive (JCP, 4.2.3).

11.2 VSORT DIRECTIVES

This section describes the VSORT directives.

a. *Required Group*

•	SORT	Sort directives follow
•	INPUT	Define logical unit for input
•	OUTPUT	Define logical unit for output
•	WORK	Define work file(s)
•	SORTKEY	Define sorting field(s)
•	ENDSORT	Begin sorting

b. Optional Group

•	INEXIT	Use input preprocessor
•	OUTEXIT	Use output preprocessor

The general form of a VSORT directive is

name = *p(1),p(2),...,p(n)* terminator

where

name is one of the VSORT directives

p(n) is a parameter required by VSORT and defined below under the descriptions of the individual directives

terminator is a blank or right parenthesis

11.2.1 SORT Directive

This directive starts the series of directives. The general form is

SORT

The word **SORT** must be followed by at least one blank. The SORT directive must be the first directive on the first control record.

11.2.2 INPUT Directive

This directive describes the sort input file which contains the records to be sorted. It has the general form

INPUT = (lun,*filename,key*,recordlength)

where

lun is a 1- to 3-character decimal number specifying the logical unit of the file

filename is a 1- to 6-character name of the file as it exists on the RMD file directory (required for all RMD files)

key is the single character file protection key, as contained in the file directory for the file (required only if the filename is present and the RMD is protected

recordlength is a 1- to 4-digit decimal number specifying the length in words of the records in the file.

Example: Describe a sort input file on magnetic tape on logical unit 18, which has 200-word records.

```
INPUT=(18,,,200)
```

11.2.3 OUTPUT Directive

This directive describes the output file which will ultimately contain the sorted records. It has the general form

OUTPUT = (**lun**,*filename,key*,**recordlength**)

where **lun**, *filename*, key and **recordlength** are the same as they are described in the INPUT directive (section 11.2.2).

Example: Describe a sort output file on a line printer logical unit 5, which has a 60-word (120-character) record.

```
OUTPUT=(5,,,60)
```

11.2.4 WORK1,WORK2,WORK3, Directives

These directives describe the intermediate work files for the sort. They have the general form

$$\textbf{WORK}\left\{\begin{matrix}1\\2\\3\end{matrix}\right\} = (\textbf{lun},\textbf{filename},key)$$

where **lun**, **filename**, and *key* are the same as described for the INPUT directive (section 11.2.2).

The work files must be RMD files. Each file must have sufficient space to contain the intermediate work records equal to the number of records in the input file for the sort.

Example: Describe intermediate sort files named W1, W2, and W3 on RMD logical unit 25. These files do not have protection keys.

```
WORK1=(25,W1),WORK2=(25,W2),WORK3=(25,W3)
```

11.2.5 SORTKEY Directive

This directive describes one to six control fields to be used to sequence the records of the sort input file. It has the general form

SORTKEY = (sc(1),ec(1),order(1),...,*sc(6),ec(6),order(6)*)

where each

sc(n) is a one- to four-digit decimal number specifying the starting character (or byte) position of the control field as it exists in the input record, or, if there positions are modified by an INEXIT routine, as they exist in the modified input record.

ec(n) is a one- to four-digit decimal number specifying the ending character (or byte) position of the control field. It must be greater than or equal to the preceding starting character position

order(n) is a single character A or D for ascending or descending sequence, respectively, for sorting the control field

At least one control field specification must be given. Each control field specification must have all three parameters specified.

Control fields may overlap.

Character positions are numbered starting with one

The significance of a control field depends on its placement in the SORTKEY directive. The first control field defined is the most important (or major) control field. The next is the secondary (used in cases of matches in the first) control field. Similarly, until the last specification given is the least important.

Collating sequence: An algebraic collating sequence is used to sort the data. Each word (in numeric data) or each byte (in character data) is interpreted as an octal number having an algebraic sign. Thus, ASCII characters have the collating sequence from 0240 (low) to 0337 (high). If characters are other than ASCII, the sign bit (bit 7) of each 8-bit character must be the same for all the characters.

Word-boundary data are treated as signed octal numbers and have the collating sequence from 0100000 (low) to 077777 (high). Thus, FORTRAN variables of integer, real, complex or logical types may be sorted with SORT control fields. FORTRAN double-precision numbers cannot be sorted because the sign of the number is not in the first word.

Example: Describe two control fields, one is bytes 27 and 28 in ascending order, and the other is byte 1 through 4 to be sorted in descending order.

```
SORTKEY=(27,28,A,1,4,D)
```

11.2.6 INEXIT Directive

This optional directive specifies whether a user-written input-exit routine is to be called at the time the input file is being read by the sort part of VSORT. The general form of the directive is

$$\text{INEXIT} = \left\{\begin{matrix}\text{YES}\\ \text{NO}\end{matrix}\right\}$$

The equal sign may be followed by a string of up to four alphabetic characters. Unless YES is specified, the default is NO (a user routine is not called). YES or NO must be followed by at least one blank.

11.2.7 OUTEXIT Directive

This optional directive specifies whether a user-written output exit routine is to be called at the time the final file output file is being created by the merge phase of VSORT. It has the general form

$$\text{OUTEXIT} = \left\{\begin{matrix}\text{YES}\\ \text{NO}\end{matrix}\right\}$$

The meaning of YES and NO is the same as described for the INEXIT directive (section 11.2.6).

11.2.8 ENDSORT Directive

This directive signals the end of the sort directives. The word ENDSORT must be followed by at least one blank as the last directive on the last control record for VSORT.

11.3 USER EXITS

User exits provide for the insertion, deletion, or modification of input and output records by user-written routines. Exits are requested by the VSORT directives, INEXIT = YES and/or OUTEXIT = YES. The exit routines written by the user are added to VSORT at load-module generation time.

The input exit routine, if provided, is called for each input record before it enters the sort. Possible uses of the input exit are

- Add input records
- Delete input records
- Create part or all of the input file
- Change input records, such as control fields

The input record length may be changed to the output record length specified on the OUTPUT directive.

The output exit routine, if provided, is called for each output record before it is written on the output file. Possible uses for the output exit are

- Add output records, effectively merging one or more files with the sorted file
- Delete sorted output records, such as duplicates
- Change the sorted output records

If output records are added or changed, it's the user's responsibility to ensure that the control fields of the output records remain in sequence.

11.3.1 Calling Sequence

VSORT uses the following calling sequence for user exits:

Word 1	JMPM XITn
Word 2	input buffer address
Word 3	output buffer address
Word 4	flag

where

n is 1 for input exit and 2 for output exit

input buffer address is the address of input record passed to the user routine (INEXIT) or the address to which the user must move a record if it is to be inserted before the output record (or EOF) passed to the user routine (OUTEXIT)

output buffer address is the address of the output record passed to the user routine (OUTEXIT) or the address to which the user must move a record if it is to be inserted before the input record (or EOF) passed to the user routine (INEXIT)

flag is set by VSORT as 0 for an EOF encountered, 1 for INEXIT, or 2 for OUTEXIT; otherwise it is set by the user routine as follows

Bit 0 = 1 accept input record (INEXIT) or insert record in input buffer before output record (OUTEXIT)
= 0 is ignore the record in the input buffer

Bit 1 = 1 accept the output record (OUTEXIT) or insert record in the output buffer before the input record (INEXIT)
= 0 ignore the record in output buffer

After EOF notification has been given to the user input (output) exit routine, the user routine may continue to pass records to VSORT in the buffer, but the contents of the buffer are ignored.

11.3.2 Implementation

The exit routines written by the user must have the following external names

XIT1	User input exit entry point
XIT2	User output exit entry point

To build a load module using user exits, place the user exit modules in front of the VSORT object module and proceed to generate a single load module.

11.4 VSORT MESSAGES

In addition to listing the VSORT directives, VSORT outputs the following totals:

a. End of sort phase totals

```
SORT PHASE COMPLETE,TOTAL MERGE
RECORDS=XXXXX

INPUT XXXXX ACCEPTED=XXXXX
INSERTED=XXXXX DELETED=XXXXX
```

b. End of merge phase totals

```
SORT COMPLETE,OUTPUT RECORDS
COUNT=XXXXX

MERGE=XXXXX ACCEPTED=XXXXX
INSERTED=XXXXX DELETED=XXXXX
```

SECTION 13

SUPPORT LIBRARY

The VORTEX system has a comprehensive subroutine library directly available to the user The library contains mathematical subroutines to support the execution of a program, plus many commonly used utility subroutines. To use the library, merely code the proper call in the program, or for the standard FORTRAN IV functions, implicitly reference the subroutine (e.g., A = SQRT(B) generates a CALL SQRT(B)). All calls generate a reference to the required routine, and the load-module generator brings the subroutine into memory and links it to the calling program

The performance of several routines in the support library is improved through the use of the V70 series Floating Point Firmware on V70 series systems having Writable Control Store (WCS). The necessary firmware and library routines which call the firmware are added to the Object Module Library (OM) by executing the supplemental WCS job stream supplied with the System Generation Library.

13.1 CALLING SEQUENCE

The subroutines in the support library are called through DAS MR or FORTRAN IV.

DAS MR: *General form*

label **CALL S**,p(1),*p(2), ,p(n)*

Expansion

```
        label     JMPM      S
                  DATA      p(1)
                  DATA      p(2)
                   .
                   .
                   .
                  DATA      p(n)
```

FORTRAN IV: *General form*

statement number **CALL** S(p(1),*p(2), ,p(n)*)

Generated code:

```
          JMPM      S
          DATA      q(1)
          DATA      q(2)
           .
           .
           .
          DATA      q(n)
```

Where q(i) = p(i) if p(i) is a single variable or array name Otherwise, q(i) = address containing p(i).

13.2 NUMBER TYPES AND FORMATS

Integers use one 16-bit word. A negative number is in two's complement form. An integer in the range − 32,767 to + 32,767 can be stored as an integer

Real numbers use two consecutive 16-bit words For a positive real number, the exponent (in excess 0200 form) is in bits 14 to 7 of the first word The mantissa is in bits 6 to 0 of the first word and bits 14 to 0 of the second word. The sign bit of the second word is zero. The negative of this number is created by one's complementing the first word Any real number in the range $10^{\pm}$[illegible] can be stored as a single-precision floating-point number having a precision of more than six decimal digits

Single-Precision Floating-Point Numbers

```
Bit   15    14 13 12   11 10 9    8  7  6    5  4  3    2  1  0
n)    s     -------Exponent---------   ----High Mantissa----
n+1)  0     ----------------Low Mantissa-----------------
```

Double-precision floating-point numbers use four consecutive 16-bit words. The exponent (in excess 0200 form) is in bits 7 to 0 of the first word. The mantissa of a positive number is in the second, third, and fourth words. Bit 15 of the second, third and fourth words and bits 15 to 8 of the first word are zero. The negative of this number is created by one's complementing the second word. Any real number in the range $10^{\pm}$[illegible] can be stored as a double-precision floating-point number having a precision of more than 13 decimal digits.

Double-Precision Floating-Point Numbers

```
Bit   15    14 13 12   11 10 9    8  7  6    5  4  3    2  1  0
n)    0     0  0  0    0  0  0    0  --------Exponent--------
n+1)  s     -----------------High Mantissa-----------------
n+2)  0     -----------------Mid Mantissa------------------
n+3)  0     -----------------Low Mantissa------------------
```

13.3 SUBROUTINE DESCRIPTIONS

The following definitions and notation apply to the subroutine descriptions given in this section.

Notation	Meaning
AB	Hardware A and B registers
AC	Four-word software accumulator for double precision numbers
ACCZ	Four-word accumulator for complex numbers (the real part is in AB and the imaginary part is in a temporary cell in subroutine V$8G)
d	Address of a double-precision number
f	Address of a two-word, fixed-point number
	Address of an integer
r	Address of a real number
S	A six character ASCII string
X	Hardware X register
z	Address of a complex number
**	Exponentiation

An additional name in parentheses indicates a replacement by standard firmware. For example, $SE(FSE) indicates the firmware routine FSE replaces $SE on 70 series systems using standard firmware. Section 20.2 describes standard firmware.

The external references in table 13-3 refer to items in tables 13-1 and 13-2. A subroutine with more than one name is indicated by multiple calls under Calling Sequence.

Table 13-1. DAS Coded Subroutines

Name	Function	Calling Sequence	External References
$HE	Given A contains i1, in A compute i1 ** i2	CALL $HE,i2	$SE(FSE), $HM
$PE	Given AB contains r, in AB, compute r ** i	CALL $PE,i	$SE(FSE), $QM, $QN
$QE	Given AB contains r1, in AB, compute r1 ** r2	CALL $QE,r2	ALOG, $QM, EXP, $SE(FSE)
ALOG	In AB, compute ln r. If r - 0, output message FUNC ARG and exit with A = B = 0 and overflow = 1	CALL ALOG,r	$EE, $QK(FAD), $QM, XDMU, XDAD, $NML, XDDI, XDSU, $SE(FSE), $PC, $QL(FSB), $QN
EXP	In AB, compute e ** r. If there is underflow, AB = 0. If overflow, AB = maximum real number and the message FUNC ARG is output. In both cases, overflow = 1	CALL EXP,r	XDMU, $QK(FAD), $NML, $EE, $QM, $QN, $SE(FSE)
ATAN	In AB, compute arctan r	CALL ATAN,r	$QM, $QL(FSB), $QN, $QK(FAD), $SE(FSE)
SINCOS	In AB, compute cos r with COS, or sin r with SIN	CALL COS,r CALL SIN,r	$QK(FAD),$QL(FSB), $QM, $QN, $SE(FSE)
SQRT	In AB, compute square root of r	CALL SQRT,r	XDDI, $FSM, $SE(FSE)
FMULDIV	Given AB contains r1, in AB, compute r1*r2 with $QM, or r1/r2 with $QN. If there is underflow, AB = 0. If overflow, AB = maximum value and the message ARITH OVFL is output. In both cases, overflow = 1	CALL $QM,r2 CALL $QN,r2	XDMU, $FMS, XDDI, $SE(FSE), $FE, $NML

Table 13-1. DAS Coded Subroutines *(continued)*

Name	**Function**	**Calling Sequence**	**External References**
FADDSUB	Given: AB contains r1, in AB, compute r1 + r2 with $QK, or r1 - r2 with $QL. If there is underflow, AB = 0. If overflow, AB = maximum value and the message ARITH OVFL is output. In both cases, overflow = 1.	CALL $QK,r2 CALL $QL,r2	$SE(FSE), $FSM, $NML, $EE
SEPMANTI	Separate mantissa and characteristic of r into AB and X, respectively	CALL $FMS CALL $FSM	None
FNORMAL	In AB, normalize r	CALL $NML	XDCO
XDDIV	In AB, compute f1/f2	CALL XDDI,f2	XDSU, XDCO
XDMULT	In AB, compute f1*f2	CALL XDMU,f2	XDAD, XDCO
XDADD	In AB, compute f1 + f2	CALL XDAD,f2	None
XDSUB	In AB, compute f1 - f2	CALL XDSU,f2	None
XDCOMP	In AB, compute negative of f	CALL XDCO	None
$FLOAT	In AB, convert the i in A to floating-point and, for $QS, store result in r	CALL $PC CALL $QS,r	$SE(FSE)
$IFIX	In A, convert the r in AB to i and, for $HS, store result in i	CALL $IC CALL $HS,i	$SE(FSE), $EE
IABS	In A, compute absolute i	CALL IABS,i	$SE(FSE)
ABS	In AB, compute absolute r	CALL ABS,r	$SE(FSE)
ISIGN	Set the sign of i1, in A, equal to that of i2	CALL ISIGN,i2	$SE(FSE)
SIGN	Set the sign of r1, in AB, equal to that of r2	CALL SIGN,r2	$SE(FSE)
$HN	Given: A holds i1, in A, compute i1/i2	CALL $HN,i2	$SE(FSE), $EE
$HM	Given: A holds i1, in A compute i1*i2	CALL $HM,i2	$SE(FSE), $EE
DSINCOS	In AC, compute sin d or cos d	CALL $DSI,d CALL $DSIN,d CALL $DCO,d CALL $DCOS,d	$STO,$DNO, $ZC, $ZK, $ZL, $SE(FSE), $ZM, $ZN, AC $DLO
DATAN	In AC, compute arctan d	CALL $DAN CALL DATAN,d	$DLO, $STO, $DAD, $DSU, IF, $SE(FSE), AC, $DMP, $DDI, POLY

Table 13-1. DAS Coded Subroutines *(continued)*

Name	Function	Calling Sequence	External References
DEXP	In AC, compute exponential d	CALL $DEX CALL DEXP,d	$DLO, $STO, $SE(FSE), AC, $DNO, $EE, $ZC, $ZK, $ZL, $ZM, $ZN
DLOG	In AC, compute ln d	CALL DLOG,d CALL $DLN	$DLO, $STO, $DNO, $EE $SE(FSE), $ZK, $ZL, $ZM, $ZN
POLY	In AC, compute double-precision polynomial with t terms, coefficient list starting at address c, and argument at address y	CALL POLY,t,c,y	$DLO, $DAD, $DMP
CHEB	In AC, compute shifted Chebyshev polynomial series with t+1 terms and coefficient list starting at address c	CALL CHEB,t,c	$DLO, $STO, $DAD, $DSU, $DMP
DSQRT	In AC, compute square root of d	CALL $DSQ,d CALL DSQR,d	$DLO, $STO, $DNO, $DAD, $DMP, $DDI, $SE(FSE), AC
$DFR	In AC, compute fractional part of d	CALL $DFR,d	$DLO, $DNO, $DSU, $DIT, AC, $SE(FSE)
IDINT	In AC, compute integral part of d	CALL $DIT,d CALL IDINT,d	$DNO, $SE(FSE)
DMULT	In AC, compute d1*d2	CALL $DMP,d2 CALL $ZM,d2	$DLO, $STO, $DNO, $DAD, AC, $SE(FSE)
DDIVIDE	In AC, compute d1/d2	CALL $DDI,d2 CALL $ZN,d2	$DLO, $STO, $DNO, $DSU, AC, $SE(FSE)
DADDSUB	In AC, compute d1+d2 with $DAD or d1 - d2 with $DSU	CALL $DAD,d2 CAL $DSU,d2 CALL $ZK,d2 CALL $ZL,d2	$STO, $DLO, $DNO, AC, $SE(FSE), $EE
DNORMAL	In AC, normalize d	CALL $DNO	$SE(FSE)
DLOADAC	Load AC with d	CALL $DLO,d CALL $ZF,d	AC, $SE(FSE)
DSTOREAC	Store AC in d	CALL $STO,d CALL $ZS,d	AC, $SE(FSE)
RLOADAC	Load A with double-precision mantissa sign word from AC	CALL $ZI	AC
SINGLE	In AB, convert the d in AC to r	CALL $RC	AC
DOUBLE	In AC, convert the r in AB to d	CALL $YC	AC
DBLECOMP	In AC, compute negative of the d in AC	CALL $ZC	AC
$3S	Store AB in memory address m	CALL $3S,m	$SE(FSE)

Table 13-1. DAS Coded Subroutines *(continued)*

Name	Function	Calling Sequence	External References
A2MT	Translate in memory a character string of length n starting at s and ending at e from eight-bit ASCII to six-bit magnetic tape BCD code s is the start of the ASCII block and e is the start of the BCD block.	CALL A2MT,n,s,e	None
MT2A	Translate in memory a character string of length n starting at s and ending at e from six-bit magnetic tape BCD code to eight-bit ASCII s is the start of the BCD block and e is the start of the ASCII block.	CALL MT2A,n,s,e	None
EXIT	Formats and executes an RTE EXIT macro	CALL EXIT	V$EXEC
SUSPND	Formats and executes an RTE SUSPND macro with parameter i	CALL SUSPND(i)	V$EXEC
RESUME	Formats and executes an RTE RESUME macro to resume task s	CALL RESUME(s)	V$EXEC, $RTENM
ABORT	Formats and executes an RTE ABORT macro to abort task s.	CALL ABORT(s)	V$EXEC, $RTENM
ALOC	Formats and executes an RTE ALOC macro to call reentrant subroutine s	CALL ALOC(s)	V$EXEC
PMSK	Formats and executes an RTE PMSK macro to operate on PIM i1 with line mask i2 and enable/disable flag i3	CALL PMSK(i1, i2,i3)	V$EXEC
DELAY	Formats and executes an RTE DELAY macro with the 5-millisecond count in i1, the minute count in i2, and delay mode in i3	CALL DELAY(i1, i2,i3)	V$EXEC
LDELAY	Formats and executes an RTE DELAY type 1 with additional parameters to specify the LUN from which the task (lun in i4 key in i5) is to be reloaded.	CALL LDELAY (i1,i2,i3, i4, i5)	V$EXEC
TIME	Formats and executes an RTE TIME macro with the minute count in i1, and 5-millisecond count in i2.	CALL TIME(i1,i2)	V$EXEC

Table 13-1. DAS Coded Subroutines *(continued)*

Name	Function	Calling Sequence	External References
OVLAY	Formats and executes an RTE OVLAY macro with i1 = 0 to execute, i2 = 0 to load, and s is the overlay name	CALL OVLAY(i1, i2,s)	V$EXEC, $RTENM
SCHED	Formats and executes an RTE SCHED macro with i1 = priority, i2 = wait flag, i3 = logical-unit number, s1 = key and s2 = task name.	CALL SCHED(i1, i2, i3,s1,s2)	V$EXEC, $RTENM
$RTENM	Moves the six-character name from X to B	CALL $RTENM	None
$EE	Outputs error messages on the SO device.	CALL $EE	VIOC, VIOST, V$EXEC
$SE	Fetches n parameters from a subroutine call	CALL $SE, n BSS n	None
V$RSW	Handles multi-reel volume files and information.	LDA = LUN to unload.	A = Restored
		LDX<0 for no mount.	B = Restored
		LDX = 0 for mount next volume.	X = Restored
		LDX>0 addr. of filename for mount.	
		B = next volume number if X>0	
		CALL V$RSW	
V$HDR	To format a standard VORTEX header.	CALL V$HDR DATA page number address DATA program name address DATA program title address (= 0 if not used)	A,B,X restored Header in 38 word external buffer V$HBUF

Table 13-2. OM Library Subroutines

Name	Function	Calling Sequence	External References
CB2A	Covert a 16-bit binary value (positive or negative) to an ASCII character string (octal or decimal) with leading zeros suppressed and right justified minus sign on negative decimal values.	LDA = 0 for octal conversion > / = 0 for decimal conversion JSR CB2A,X DATA Address of binary value	(A) = Address of ASCII string (B) = Restored
CA2B	Convert a decimal or octal ASCII number (positive or negative decimal) to a 16-bit binary value. '+' sign not allowed! leading 0 ⇒ octal '−' only for decimal	JSR CA2B,X DATA ASCII string address (compl = left byte, pos = right byte) DATA Address of termination character block **The termination block format is** DATA Legal termination character (right justified) DATA Legal termination character (right justified) • • • DATA 0 (end of block)	(A) = Binary value (B) = Next byte address OVFL = Set if an illegal character encountered
MOVE	Move a block of n words from address f to address t. If an overlap move, then, move in reverse.	JSR MOVE,X DATA n (word count) DATA f (from address) DATA t (to address)	(A) = Restored (B) = Restored
CTIME	Convert the time of day to an ASCII string of the form: HH:MM:SS	JSR CTIME,X	(A) = Address of ASCII string (B) = Restored

Table 13-3. FORTRAN IV Coded Subroutines

Name	Function	Calling Sequence	External References
$9E	Compute ACCZ**i	CALL $9E(i)	$SE(FSE), IABS, $8F, $8M, $8N, $8S
CCOS	In ACCZ, compute cos z	CALL CCOS(z)	$SE(FSE), CSIN, $8F, $8K, $8S
CSIN	In ACCZ, compute sin z	CALL CSIN(z)	$SE(FSE), EXP, $QN, SIN, $QK(FAD), $QM, COS, $QL(FSB), $8F
CLOG	In ACCZ, compute ln z	CALL CLOG(z)	$SE(FSE), ALOG, $QM, $QK(FAD), $QN, ATAN2, $8F
CEXP	In ACCZ, compute exponential z	CALL CEXP(z)	$SE(FSE), EXP, COS, $QM, SIN, $8F
CSQRT	In ACCZ, compute square root of z	CALL CSQRT(z)	$SE(FSE), SQRT, CABS $QK, $QN, $8F
CABS	In AB compute absolute z	CALL CABS(z)	$SE(FSE), SQRT, $QM, $QK(FAD)
CONJG	In ACCZ, compute conjugate of z	CALL CONJG(z)	$SE(FSE), $8F
$AK	Add r to real part of ACCZ	CALL $AK(r)	$SE(FSE), $8S, $QK(FAD), $8F
$AL	Subtract r from the real part of ACCZ	CALL $AL(r)	$SE(FSE), $8S, $QL(FSB), $8F
$AM	Multiply ACCZ by r	CALL $AM(r)	$SE(FSE), $8S, $QM, $8F
$AN	Divide ACCZ by r	CALL $AN(r)	$SE(FSE), $8S, $QM, $8F
$AC	Convert AC to z and store in ACCZ	CALL $AC	$3S, CMPLX
CMPLX	Load ACCZ with a value having a real part r1 and an imaginary part r2	CALL CMPLX(r1,r2)	$SE(FSE), $8F
$8K	Add z to ACCZ	CALL $8K(z)	$SE(FSE), $8S, $QK(FAD), $8F
$8L	Subtract z from ACCZ	CALL $8L(z)	$SE(FSE), $8S, $QL(FSB), $8F
$8M	Multiply ACCZ by z	CALL $8M(z)	$SE(FSE), $8S, $QM, $QL(FSB), $QK(FAD), $8F

Table 13-3. FORTRAN IV Coded Subroutines *(continued)*

Name	Function	Calling Sequence	External References
$8N	Divide ACCZ by z	CALL $8N(z)	$SE(FSE), $8S, $QM, $QK(FAD), $QN, $QL(FSB), $8F
$ZD	Compute negative of z	CALL $ZD	$8S, $8F
AIMAG	Load AB with the imaginary part of z	CALL AIMAG(z)	$SE(FSE)
$OC	Load AB with the real part of ACCZ	CALL $OC	$8S
REAL	Load AB with the real part of z	CALL REAL(z)	$SE(FSE)
$8F	Load ACCZ with z	CALL $8F(z)	$SE(FSE)
$8S	Store ACCZ in z	CALL $8S(z)	$SE(FSE), $3S
$XE	Compute d**i where d is in AC	CALL $XE(i)	$SE(FSE), $ZF, MOD, $ZM, $HN, $ZN, $ZS
$YE	Compute d**r where d is in AC	CALL $YE(r)	$SE(FSE), $ZS, DBLE, $ZE, $ZF
$ZE	Compute d1**d2 where d1 is in AC	CALL $ZE(d2)	$SE(FSE), $ZS, DEXP, DLOG, $ZM
DATAN2	In AC, compute arctan (d1/d2)	CALL DATAN2(d1,d2)	$SE(FSE), $ZF, $ZS, $ZI, $ER, $ZN, $ZL, $ZK, DATAN
DLOG10	In AC, compute log d	CALL DLOG10(d)	$SE(FSE), DLOG, $ZM
DMOD	In AC, compute d1 modulo d2	CALL DMOD(d1,d2)	$SE(FSE), DINT, $ZF, $ZN, $ZS, $ZM, $ZL, $ZC
DINT	In AC, compute integer portion of d	CALL DINT(d)	$SE(FSE), $ZF, $JC, $XC
DABS	In AC, compute absolute d	CALL DABS(d)	$SE(FSE), $ZF, $ZI, $ZC
DMAX1	In AC, select the maximum value in the set d1, d2,...,dn	CALL DMAX1(d1,d2 ...,dn,0)	$SE(FSE), $ZF, ZS, IFA, $ZL, $ZI
DMIN1	In AC, select the minimum value in the set d1, d2,...,dn	CALL DMIN1(d1,d2 ...,dn,0)	$SE(FSE), $ZF, ZS, IFA, $ZL, $ZI
DSIGN	Set the sign of d1 equal to that of d2	CALL DSIGN(d1,d2)	$SE(FSE), $ZF, $ZI, $ZN
$YK	Add r to AC	CALL $YK(r)	$SE(FSE), $ZS, DBLE, $ZK
$YL	Subtract r from AC	CALL $YL(r)	$SE(FSE), $ZS, DBLE, $ZL, $ZC
$YM	Multiply AC by r	CALL $YM(r)	$SE(FSE), $ZS, DBLE, $ZM

Table 13-3. FORTRAN IV Coded Subroutines *(continued)*

Name	Function	Calling Sequence	External References
$YN	Divide AC by r	CALL $YN(r)	$SE(FSE), $ZS, DBLE, $ZF, $ZN
DBLE	In AC, convert r to d	CALL DBLE(r)	$SE(FSE), $YC
$XC	In AC, convert i to d where i is in A	CALL $XC	$PC, $YC
TANH	In AB, compute tanh r	CALL TANH(r)	$SE(FSE), $QK(FAD), EXP, $QL(FSB), $QN
ATAN2	In AB, compute arctan (r1/r2)	CALL ATAN2(r1,r2)	$SE(FSE), $ER, ATAN, $QK(FAD), $QL(FSB), $QN
ALOG10	In AB, compute log r	CALL ALOG10(r)	$SE(FSE), ALOG, $QM
AMOD	In AB, compute r1 modulo r2	CALL AMOD(r1,r2)	$SE(FSE), AINT, $QN, $QM, $QL(FSB)
AINT	In AB, truncate r	CALL AINT(r)	$SE(FSE), $IC, $PC
AMAX1	In AB, select the maximum value in the set r1,r2,...,rn	CALL AMAX1(r1,r2) ...,rn,0)	$SE(FSE), I$FA, $QL(FSB)
AMIN1	In AB, select the minimum value in the set r1, r2, ..,rn	CALL AMIN1(r1,r2) ..,rn,0)	$SE(FSE), I$FA, $QL(FSB)
AMAX0	In AB, select the maximum value in the set i1,i2,...,in and convert to r	CALL AMAX0(i1,i2, ..,in,0)	$SE(FSE), I$FA, FLOAT
AMIN0	In AB, select the minimum value in the set i1,i2,...,in and convert to r	CALL AMIN0(i1,i2, ...,in,0)	$SE(FSE), I$FA, FLOAT
DIM	In AB, compute the positive difference between r1 and r2	CALL DIM(r1,r2)	$SE(FSE), $QL(FSB)
FLOAT	In AB, convert i to r	CALL FLOAT(i)	$SE(FSE), $PC
SNGL	In AB, convert d to r	CALL SNGL(d)	$SE(FSE), $ZF, $RC
MAX0	In A, select the maximum value in the set i1,i2,...,in	CALL MAX0(i1,i2, ...,in,0)	$SE(FSE), I$FA
MIN0	In A, select the minimum value in the set i1,i2,...,in	CALL MIN0(i1,i2, ...,in,0)	$SE(FSE), I$FA
MAX1	In A, select the maximum value in the set r1,r2,...,rn and convert to i	CALL MAX1(r1,r2, ...,rn,0)	$SE(FSE), I$FA, $QL(FSB), IFIX
MIN1	In A, select the minimum value in the set r1,r2,...,rn and convert to i	CALL MIN1(r1,r2, ...,rn,0)	$SE(FSE), I$FA, $QL(FSB), IFIX
MOD	In A, compute i1 modulo i2	CALL MOD(i1,i2)	$SE(FSE), $HN, $HM

Table 13-3. FORTRAN IV Coded Subroutines *(continued)*

Name	Function	Calling Sequence	External References
INT	In A, truncate r and convert to i	CALL INT(r)	$SE(FSE), $IC
IDIM	In A, compute the positive difference between i1 and i2	CALL IDIM(i1,i2)	$SE(FSE)
IFIX	In A, convert r to i	CALL IFIX(r)	$SE(FSE), $IC
$JC	In AC, convert d to i and store result in A	CALL $JC	$RC, $IC

13.4 DECIMAL SUBROUTINE

The decimal subroutine performs requested decimal operations (add, subtract, multiply, divide, move, or compare). Besides operand addresses and sizes, the user may specify pre-shifting of operands and post-shifting and rounding of result. Note that pre-shifting is decimal alignment and does not imply physical shifting. Operands may be signed or unsigned.

Decimal compare sets the user result condition word as follows:

= 0	if operand A< operand B
= 1	if operand A = operand B
= 2	if operand A > operand B

Decimal compare arithmetically compares two decimal operands.

On entry register R0(A) contains the address of an 85 word temporary storage block available to firmware, R1(B) contains the address of the user result condition word, and R2(X) contains the address of the users descriptive parameter block. Decimal math may be accessed either via

```
        JMPM        V$DECM
or
        JMP         C$DECM
```

If C$DECM is used, return will be made to user supplied location VC$RTN. If V$DECM is used, the user must still define VC$RTN.

Parameter Block

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	CODE			P	LA	UB	LA					LB				
1	BN_A				displacement$_A$											
2	BN_B				displacement$_B$											
3				Q	DA	DB	SA					SB				
4				R	UC	DC	LC					SC				
4 .	BN_C				displacement$_C$											

Parameter Description:

CODE represents operation to be performed:

0 = opA + opB
1 = opA - opB
2 = compare opA: opB
3 = move opA to opB
4 = opA * opB
5 = opA/opB

P	= 1	for presence of word 3.
	= 0	for absence of word 3.
UA	= 1	if operand A is unsigned.
	= 0	if operand A is signed.
UB	= 1	if operand B is unsigned.
	= 0	if operand B is signed.
LA	= length of A in digits (1 to 31).	
LB	= length of B in digits (1 to 31).	
BN_A	= main storage base register number of operand A.	
BN_B	= main storage register number of operand B.	
Q	= 1	if returned in third operand (words 4 and 5 present).
	= 0	if third operand not present (words 4 and 5 absent).
DA	= 1	pre shift operand A left
	= 0	pre shift operand A right
DB	= 1	pre shift operand B left
	= 0	pre shift operand B right
SA	=	Operand A shift amount
SB	=	Operand B shift amount
R	= 1	if rounding to be applied to result (only if result returned in third operand)
	= 0	if rounding not applied to result
UC	= 2	if result unsigned
	= 0	if result signed
DC	= 1	to shift result left
	= 0	to shift result right
LC	=	length of result field
SC	=	result shift amount
BN_C	=	main storage base register number of result
Displacement A, B, or C	=	Byte count used to calculate byte address of decimal operands.

Error Conditions:

(Note that on an error, register R2 will be incremented past the parameter block, and results will be unreliable.)

a. Result operand overflow - if the result operand has an inadequate number of digits to contain the result, the condition result word (CONDIT) will be set to the value 3.

b. Invalid digit - if the number portion of a digit (bits 2^3 - 2^0) contains a value other than 0 - 9_{10} or the zone portion (bits 2^7 - 2^4) contains a value other than 11_{10}, the conditions result word will be set to the value 4. This is also true of values specified as signed having signs other than blank (octal 240), minus (octal 255), or plus (octal 253).

c. If the base word related to respective BN field is zero then the condition result word CONDIT will be set to 5.

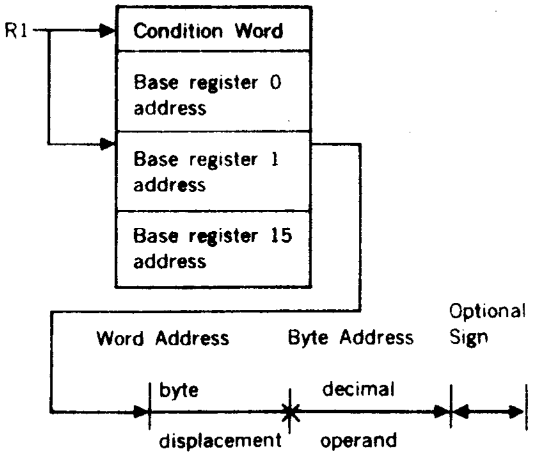
d. Attempted division by zero results in CONDIT being set to 3.

Notes

If operand C is not specified, the result will be returned in operand A, except for move. Decimal move moves operand A to operand B. Note that for a decimal move, the parameter block may be a maximum of 4 words. In this case, the Q bit is used to specify rounding, rather than a third operand.

Parameter byte addresses are calculated as follows: (R1 + 1 + BN) *2 + displacement = byte address of least significant byte of decimal operand.

This represented pictorially as follows:



When pre-shifting is specified, this does not imply physical shifting of operands. Only the operand designated for result is modified by a decimal operation.

When the operation is complete, only the integrity of register R2 and R1 are maintained. R2 will be incremented to the address of the next word following the parameter block.

This is meant to imply all other V75 registers are volatile. The user must save and restore any registers R3 through R7 he requires to be maintained when executing the decimal operation.

Examples:

Note: The following may be used to create decimal parameter blocks:

```
                     FOLLOWING ARE FORMS OF DECIMAL
                     INSTRUCTION

DWORD0  FORM    3,1,11,5,5
DWORD1  FORM    4,12
DWORD2  FORM    4,12
DWORD3  FORM    3,1,1,1,5,5
DWORD4  FORM    3,1,1,1,5,5
DWORD5  FORM    4,12

                     DECIMAL OPERATION MACRO (DECIMAL
                     PARAMETER BLOCK)

DECOP      MAC
           IFT      P(12)-P(13)-P(5)-P(6)+P(14)      Select appropriate Word 0
           GOTO     DECWD1                           (Note no third, fourth,
           DWORD0   P(7),0,P(1),P(3),P(4),P(11)      or fifth word)
           GOTO     DECWD2
DECWD1     COUNT
           DWORD0   P(7),1,P(1),P(8),P(4),P(11)      (Parameter block includes
DECWD2     CONT                                      at least word 3)
           DWORD1   P(2),P(3)
           DWORD2   P(9),P(10)
           IFF      P(12)+P(13)+P(5)+P(6)+P(14)
           GOTO     DECWD3                           (Terminate if no word 3)
           DWORD3   0,P(14)P(5),P(12),P(6),P(13)
           IFF      P(14)
           GOTO     DECWD3                           (Terminate if no third
           DWORD4   0,P(15),P(16),P(20),P(19),P(21)      operand words 4 and 5)
           DWORD5   P(17),P(18)
DECWD3     CONT
           EMAC

        INTERPRETIVE PARAMETER BLOCK DEFINED AS FOLLOWS:

           P(01)    OP1         SIGNED (S) OR UNSIGNED (U)
           P(02)    OP1         REG
           P(03)    OP1         DISPLACEMENT
           P(04)    OP1         LENGTH
           P(05)    OP1         SHIFT LEFT (L) OR RIGHT (R)
           P(06)    OP1         SHIFT AMOUNT
           P(07)                OPERATION (DADD, DSUB, SMULL, DDIV,
                                DMOV, DCMP)
           P(08)    OP2         SIGNED (S) OR UNSIGNED (U)
           P(09)    OP2         REG
           P(10)    OP2         DISPLACEMENT
           P(11)    OP2         LENGTH
           P(12)    OP2         SHIFT LEFT (L) OR RIGHT (R)
           P(13)    OP2         SHIFT AMOUNT
           P(14)    =EQ      IF RESULT IN THIRD OPERAND
           P(15)    F           FOR ROUNDING
           P(16)    OP3         SIGNED (S) OR UNSIGNED (U)
           P(17)    OP3         REG
           P(18)    OP3         DISPLACEMENT
           P(19)    OP3         LENGTH
           P(20)    OP3         SHIFT LEFT (L) OR RIGHT (R)
           P(21)    OP3         SHIFT AMOUNT
```

Following are equates to be used with the above macro:

BN0	EQU	0	BASE NUMBER 0
BN1	EQU	1	BASE NUMBER 1
BN2	EQU	2	BASE NUMBER 2
BN3	EQU	3	BASE NUMBER 3
BN4	EQU	4	BASE NUMBER 4
BN5	EQU	5	BASE NUMBER 5
BN6	EQU	6	BASE NUMBER 6
BN7	EQU	7	BASE NUMBER 7
BN8	EQU	8	BASE NUMBER 8
BN9	EQU	9	BASE NUMBER 9
BNA	EQU	10	BASE NUMBER 10
BNB	EQU	11	BASE NUMBER 11
BNC	EQU	12	BASE NUMBER 12
BND	EQU	13	BASE NUMBER 13
BNE	EQU	14	BASE NUMBER 14
BNF	EQU	15	BASE NUMBER 15
DADD	EQU	0	DECIMAL ADD
DSUB	EQU	1	DECIMAL SUBTRACT
DCMP	EQU	2	DECIMAL COMPARE
DMOV	EQU	3	DECIMAL MOVE
DMUL	EQU	4	DECIMAL MULTIPLY
DDIV	EQU	5	DECIMAL DIVIDE
EQ	EQU	1	RESULT RETURNED IN C
F	EQU	1	ROUND (ADJUST)
R	EQU	0	SHIFT RIGHT
L	EQU	1	SHIFT LEFT
S	EQU	0	SIGNED
U	EQU	1	UNSIGNED

The above macro may be used as follows:

```
1. DECOP U, BN1,2,4,R,1,DAD,U,BN2,0,4,L1
```

generates four word parameter block

```
16204
10002
20000
02041
```

Explanation: Operand A is an unsigned decimal string residing in memory accumulator 1. It begins (most significant digit) two bytes into accumulator 1 with a length of four bytes. Operand A will be logically reshifted right one digit. Operand B is an unsigned decimal string beginning in memory accumulator 2 with a length of four bytes. Operand B will be logically pre-shifted left one digit. The result of addition will be returned in operand A. If operand A = 4310 and operand B = 0129, result of the above operation would be 1721.

Note following register settings.

	Before Operation	After Operation
R0(A)	1016	1016
R1(B)	3100	3100
R2(X)	4102	4106

```
2. DECOP U,BN5,0,4,,,DMUL,S,BNE,0,3,,,
       EQ,F,U,BN1,0,7,R,1
```

generates six word parameter block

```
114203
050000
160000
010000
014341
010000
```

Explanation: An unsigned 4 digit decimal string in memory accumulator 5 is multiplied by a signed 3 digit decimal string in memory accumulator 14. The result will be right shifted one digit position, rounded, and stored in memory accumulator 1 (note maximum resulting digit string length is 7). If operand A = 0321 and operand B = 987 + result of above operation would be 0003168.

Note following register settings:

	Before Operation	After Operation
R0(A)	1200	1200
R1(B)	1105	1105
R2(X)	3506	3514

```
3.    DECOP S,BNC,0,3,,,DCMP,S,BN1,0,4
```

generates three word parameter block

```
040144
150000
010000
```

Example 3 compares decimal digit string in memory accumulator D with decimal digit string in memory accumulator 1. If operand A = 123 + and operand B = 9871-, condition word pointed to by R1(B) would be set to 20

Note following register settings:

	Before Operation	After Operation
R0(A)	13012	13012
R1(B)	6512	6512
R2(X)	1234	1237

SECTION 14
REAL-TIME PROGRAMMING

VORTEX real-time applications allow the user to interface directly with special devices, develop software that is interrupt-driven, and utilize reentrant subroutines. Four areas are covered in this section:

- Interrupts
- Task-scheduling
- Coding reentrant subroutines
- Coding I/O drivers

14.1 INTERRUPTS

14.1.1 External Interrupts

Priority interrupt module (PIM) hardware: A PIM comprises a group of eight interrupt lines and an eight-bit register. The register holds a mask where each set bit disarms a line. VORTEX allows up to eight PIMs for a maximum of 64 lines. The system of PIMs and lines is called the *external interrupt system.*

The processing of external interrupts is controlled by the programmed status of the line. The lines are continuously hardware-scanned, regardless of the status.

If more than one interrupt is detected on a single scan, the highest-priority line is acknowledged, and, if the PIM is enabled and the line armed, the interrupt is taken. If no conflict occurs, the lines are acknowledged on a first-in/first-out basis. If a signal is received on a disabled PIM, it is stored by the PIM, and causes an interrupt when the PIM is enabled.

Disabling the external interrupt system prevents any interrupt from entering the computer. Enabling the entire system allows acknowledgement of all interrupts. Enable/disable selection on a PIM basis allows for more selected control of the system. Individual line selection prevents receiving a second interrupt while a line is still processing the first.

Program setting of PIM registers causes the PIM to ignore interrupts received on lines that are busy processing an interrupt or held off because of priority.

All PIMs and interrupt lines to be used in VORTEX are specified at system-generation time and their status specified when VORTEX is loaded and initialized. VORTEX does not disable any line unless so directed by RTE service request PMSK (section 2.1.6).

When a PIM interrupt signal is acknowledged and the interrupt taken, the computer executes the instruction in a selected memory location. Under VORTEX, PIM addresses are from 0100 to 0277. Linkage to VORTEX interrupt-processing routines is accomplished by a jump-and-mark instruction in the interrupt location. Unspecified lines are preset in VORTEX with no-operation instructions that ignore unspecified or spurious interrupts.

Since VORTEX always includes memory protection, certain instruction sequences cannot be interrupted and acknowledgement is delayed until they are complete. These include the instruction following an external control, halt, execution, or any instruction manually executed in step mode.

VORTEX interrupt line handlers: At system-generation time, a user specifies all interrupt-driver tasks. These include those that allow VORTEX to service the interrupt, as well as those that are directly connected and service the interrupt themselves. Then, VORTEX constructs a line handler for each interrupt in the system (figure 14.1).

Directly connected routines preempt VORTEX and are thus used only when response time demands it. Section 14.4.5 describes directly connected interrupt handlers in detail.

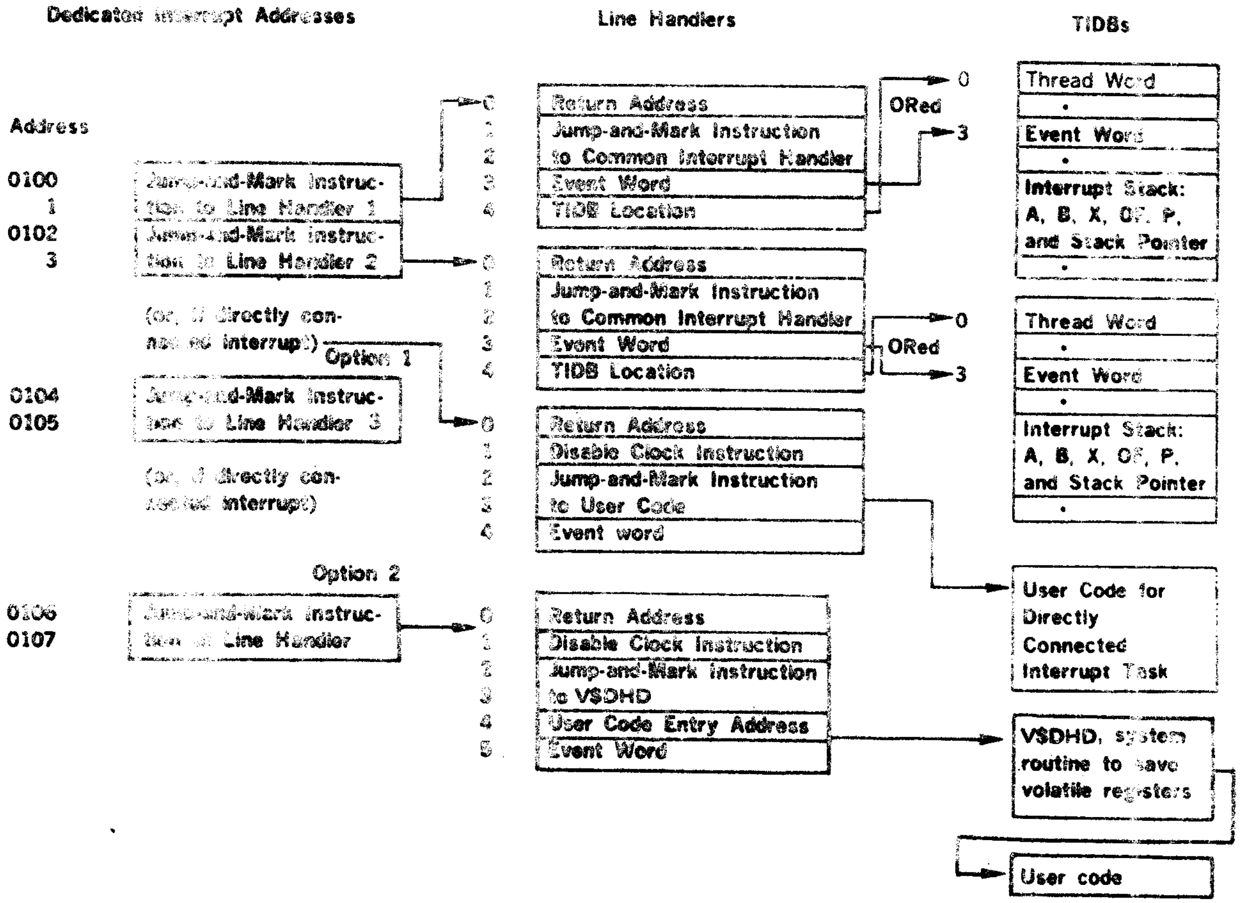
Common interrupt handler: The common interrupt handler is the interface between PIM interrupts (via the line handlers) and system or user interrupt-processing tasks. Upon entry, the contents of the volatile registers are saved and the interrupt event word is inclusively ORed into the event word of the specified TIDB. A check then determines whether to return to the interrupted task or to enter the interrupt-processing task, depending upon priority. All interrupts are enabled upon leaving the common interrupt handler.

Interrupt-processing tasks: A task is activated by an interrupt when: (1) task's TIDB interrupt-expected status bit is set, (2) the interrupt event word contains a nonzero, and (3) the task is suspended.

The interrupt-processing task can be memory-resident or RMD-resident, In either case, the processing task clears the event word. The event word distinguishes different interrupt lines that could activate the same task. The dispatcher clears the interrupt expected bit and time delay active for all tasks except TTY and CRT drivers.

An interrupt-processing task can exit with one of the following options:

a. Issue a suspend RTE (type 1 or 2) service call that suspends the task and sets the interrupt-expected status bit. Upon receiving the external interrupt or simulated interrupt (TBEVNT word in TIDB is set to 1) caused by IOC or I/O completion events (type 2 only), the task continues execution following the request.


Dedicated Interrupt Addresses
Line Handlers
TIDBs
Address
0100
1
0102
3
Jump-and-Mark Instruction to Line Handler 1
Jump-and-Mark Instruction to Line Handler 2
(or, if directly connected interrupt)
Option 1
0104
0105
Jump-and-Mark Instruction to Line Handler 3
(or, if directly connected interrupt)
Option 2
0106
0107
Jump-and-Mark Instruction to Line Handler
Return Address
Jump-and-Mark Instruction to Common Interrupt Handler
Event Word
TIDB Location
ORed
Return Address
Jump-and-Mark Instruction to Common Interrupt Handler
Event Word
TIDB Location
ORed
Return Address
Disable Clock Instruction
Jump-and-Mark Instruction to User Code
Event word
Return Address
Disable Clock Instruction
Jump-and-Mark Instruction to V$DHD
User Code Entry Address
Event Word
0
1
2
3
4
5
Thread Word
Event Word
Interrupt Stack: A, B, X, OF, P, and Stack Pointer
Thread Word
Event Word
Interrupt Stack: A, B, X, OF, P, and Stack Pointer
User Code for Directly Connected Interrupt Task
V$DHD, system routine to save volatile registers
User code

Note: See section 14.4.5 on directly-connected interrupt handler.

Figure 14-1. Interrupt Line Handlers

b. Issue a delay RTE (type 2 or 3) service call that suspends the task and sets the interrupt-expected and time-delay active status bits. The task is reactivated when time-delay expires or upon receipt of external interrupt or a simulated interrupt caused by IOC or I/O completions (type 3 only).
   Upon entry, the event word non-zero indicates interrupt activation by external or simulated interrupt (1). Since IOC set the TIDB event word to a 1, the event word in line handlers for external interrupts should be set to something other than 1 if a type 3 delay is to be used. The word also clears the time-delay status bit upon reactivation.
   It should also be noted that for suspend (type 2) and delay (type 3) service calls, bit 6 of TBPL word of task's TIDB is set to cause IOC to set TBEVNT word to 1 on I/O completion events. This bit is reset whenever a suspend or delay service call of a type other than the ones mentioned above.

c. If RMD-resident, set the interrupt-expected status bit and call EXIT to release space. (TIDB must be resident.)

Timing Considerations: The time necessary to process an interrupt through the common interrupt handler depends on when the interrupt occurred:

a. If a task is interrupted and the interrupt-processing task has a lower priority, the interrupt is posted, and VORTEX returns control to the interrupted task in approximately 56 cycles.

b. If a task is interrupted and the interrupt-processing task has a higher priority, the interrupt is posted, and VORTEX transfers control to the dispatcher (section 14.2.3) to start the higher-priority interrupt-processing task (if all its conditions are met). The posting time is 66 cycles, approximately.

c. If an interrupt occurs during a dispatcher scan, the posting time is about 32 cycles. VORTEX returns to the dispatcher to restart the scan.

d. If the real-time clock interrupts the interrupt handler, the RTC interrupt handler posts the interrupt and the common interrupt handler returns to the clock processor in approximately 40 cycles.

14.1.2 Internal Interrupts

VORTEX recognizes and services internal interrupts related to various hardware components. The processing routines are all directly connected and are the highest-priority tasks in the system.

Memory protection interrupt: Memory protection interrupts are generated when a task attempts to execute a privileged instruction such as external control or halt, or attempts to violate the access mode. The memory protection routines process all protection violation interrupts which are the highest priority interrupts in the system. When the interrupt occurs, the system is forced to the executive mode, state 0 (see table 1-1). Section 1.3 describes the memory map concept and the access modes which can be assigned to each virtual page.

VORTEX uses the memory protection interrupt for switching from the user mode to the executive mode when an I/O (section 3) or RTE (section 2) request is made.

The memory protection interrupt addresses for the various violations are shown in table 14-1.

Table 14-1. Memory Protection Interrupt Addresses

Error	Interrupt Address	Map Active Access Control Status
HALT	020	Attempt was made to execute HALT instruction.
I/O	022	A map number other than 0 attempted to execute an I/O instruction.
WRITE	024	Attempt was made to write into read-only or execute-only location.
JUMP	026	Attempt was made to jump into read operand only location.
UNASSIGNED	030	Attempt was made to read or write into unassigned location.
INSTRUCTION FETCH	032	Attempt was made to fetch instruction from read operand only location.

Power failure/restart interrupt: An interrupt occurs when the system detects a power failure. The VORTEX power failure processor saves the contents of volatile registers and the status of the overflow indicator, sets a power failure flag, and halts with the I register set to 077.

Following the power-up sequence, the PF/R hardware generates an interrupt. Upon entry to the VORTEX power-up procesor, the power-failure flag is checked. A power-down sequence must have occurred or else a fatal error condition is assumed to have occurred and VORTEX halts with the I register set to 077.

If a power-down sequence had occurred, the power-failure flag is cleared, the PIM mask registers are set, the real-time clock's variable interrupt interval is set, the saved volatile registers are restored, the clock and PIMs are enabled (if enabled upon interrupt), and control is returned to the location before the interrupt. Any input or output data transfers in operation at the time of the power failure result in the loss of data.

For peripheral devices such as magnetic tapes and RMDs, the I/O operation is automatically retried.

For other peripheral devices, such as the card reader, paper-tape system, card punch and lineprinter, a retry is not attempted.

The error message posted depends upon the error detected by the respective I/O driver, such as abnormal BIC stop, parity error, interrupt time-out, etc. Data losses on the RMD due to power failure could cause VORTEX to malfunction, but other devices which are not system-resident are recoverable.

The power failure-restart routines operate at the second-highest priority level in the system, which has memory protection at the highest priority level.

The power-up routine reloads the volatile memory map registers by scanning the TIDB thread and outputting the map image for each task which has an assigned, non-checkpointed map. Each task's map key number is contained in TBKEY and the map image adddress contained in TBMING.

The power-up routine also automatically reloads the writable control store for systems with WCS. Sections 20.1.3 and 20.1.4 describe the manner in which the microutility task saves the WCS image in the OM library file named WCSIMG and how the WCS reload task, WCSRLD, utilizes the file to restore the WCS content. The power-up routine checks location 017 to determine if WCS has been loaded. A zero value indicates no WCS. A non-zero value is assumed to be the WCSRLD TIDB address. The FL library logical unit number and protect key are stored in TBRSTS and the WCSRLD TIDB (resident TIDB, non-resident task) is set active.

Real-time clock interrupt: The real-time clock interrupt provides the basis for timekeeping in VORTEX. It can be set to a minimum resolution of 5 milliseconds. However, a value greater than 5 milliseconds (i.e., 10-20 milliseconds) reduces overhead when the system does not have high-resolution timekeeping requirements. Upon receipt of an interrupt, the time-of-day is updated and the TIDBs are scanned for any time-driven task requiring activation. PIMs are disabled for approximately 18 cycles during real-time clock interrupt-processing. The clock routine is the third-highest priority interrupt in VORTEX.

14.1.3 Interrupt-Processing Task Installation

To install an interrupt-processing task that is not directly connected, at system generation time provide line handlers and resident TIDBs by using a PIM directive (section 15.5.11) with s(n) zero and a TDF directive (section 15.6.2) using the same task name in both directives. Additional dummy TIDBs can be added during system generation. (Once a TIDB is in the system, OPCOM directive ;ATTACH can be used to connect different interrupt-processing tasks to an interrupt line.)

Then, code the interrupt-processing task and add the task via system generation to the VORTEX nucleus as a resident task.

Then, use the ;ATTACH directive to link the resident task to the interrupt line (if PIM directive not used).

14.1.4 Interrupt State

When a memory-protection, real-time (RT) clock or PIM interrupt occurs, the system is forced to the executive mode, state 0. The interrupts are enabled or disabled as follows:

a. Memory-Protection Interrupt

1. RT clock is unaffected and remains in the enabled state.

2. Memory protection is disabled and is enabled prior to exiting the memory- protection processing routine (EXC 0646).

3. PIMs are disabled when the JMPM instruction is executed and PIMs are enabled prior to exiting (EXC 0244).

b. PIM Interrupt

1. RT clock is unaffected and remains in the enabled state. The common interrupt line handler routine disables and enables the RT clock. The clock is not enabled if the PIM interrupted out of the RT clock processor (see section 14.4.5 for directly connected interrupt handlers).

2. Memory protection is unaffected and remains in the enabled state.

3. PIMs are disabled when the JMPM instruction is executed. The common interrupt line handler routine enables the PIMs upon exiting.

c. RT Clock Interrupt

1. The RT clock processor disables and reenables the RT clock.

2. Memory protection is unaffected and remains in the enabled state.

3. The PIMs are disabled when the JMPM instruction is executed. The RT clock processor enables the PIMs.

14.2 SCHEDULING

14.2.1 System Flow

VORTEX is designed around the TIDB (table 14-1). This block contains all of the information about a task during its execution. The setting and clearing of status bits in the TIDB causes a task to flow through the system. Two register stacks are saved within the TIDB: a reentrant (suspend register) stack, and an interrupt stack.

The dispatcher (section 14.3) is the prime mover of tasks through the system. When any function has reached a termination point or has to wait for an I/O operation, the task gives control to the dispatcher, which then finds another task to execute. A task maintains control until it gives control to the dispatcher, or to the interrupt task if the interrupt-processing task has a higher priority. The contents of the interrupted task's volatile registers are saved in its TIDB interrupt stack and control goes to the dispatcher, which searches for the highest-priority active task for execution.

Each TIDB is placed in sequence by priority level and threaded. Two stacks are maintained in the system: a busy stack and an unused stack. When a task is scheduled for execution, a TIDB is allocated from the unused stack and threaded onto the busy stack according to priority level.

The status word of each TIDB, starting with the highest-priority task, is scanned. Depending upon the setting of status bits, the task is activated, passed over, or made to activate a related system task.

Two resident system tasks are activated by the dispatcher to process functions relating to the execution of a task: (1) search, allocate, and load (SAL), and (2) common system errors (ERROR). SAL searches, allocates, loads, and exits a scheduled task. ERROR posts common system error messages. These two tasks are not reentered once they start execution, so the dispatcher holds tasks requiring identical functions until they are completed. Then, the highest-priority waiting task is given control of the required function.

In VORTEX, SAL assigns a map (1-15) to each non-resident task scheduled to be executed. If a map is not available, SAL: (1) checkpoints any executing background task's map (memory is checkpointed as required only); (2) checkpoints a lower priority foreground task's map; or (3) checkpoints a higher priority foreground task's map (if TBST bit 8 is set); or (4) exits and does not execute the task until a map becomes available.

Each map defines a logical memory space of 32K words which is segmented into 512-word pages (see section 1.3). SAL sets each logical page to one of four access modes: unassigned, read only, read operand only, or read-write. Each logical page which is assigned an access mode other than unassigned is linked to a physical page of memory. If the access mode is violated by the executing task, a memory protect interrupt occurs. The memory protection interrupt processing is described in section 14.1.2. Page 0 (logical addresses 0-0777) is always assigned to physical page 0, which is the system data region as defined in table 14-1.

Each task, foreground or background, executes within its own logical memory space. The amount of logical memory space available to a task is reduced by: (1) page 0 for system data; and (2) the VORTEX nucleus module accessed by the task and mapped into its logical memory (see section 2.2). If none of the VORTEX nucleus module is accessed, the task has available all but one page (page 0) of the 32K logical memory space. Each task is loaded and executed from logical address 01000. Section 1.3 describes in greater detail available logical memory space.

SAL allocates physical memory by pages. SAL maintains a table designating the allocatability of each physical page within the system as defined during system generation.

If space is not available and the background is in operation, the background task is checkpointed on the RMD checkpoint file and its space allocated to foreground. Upon release of this space by the foreground tasks, the background is read in from the RMD and reactivated.

If space is required to load a program and the background has already been checkpointed, the task waits for a currently running task to exit and release memory.

A task may dynamically request more memory space via the ALOCPG and MAPIN RTE requests. Sections 2.1.15 and 2.1.17 further describe these RTE requests.

The background memory allocation depends on the size of the background task being loaded. Only the amount needed is so allocated automatically, although the JCP/MEN directive can allocate extra memory for a background task. Figure 14-2 is a VORTEX memory map of map 0, figure 14-3 shows the priority structure, table 14-2 is a description of a TIDB, and table 14-3 is a detailed description of lower memory.

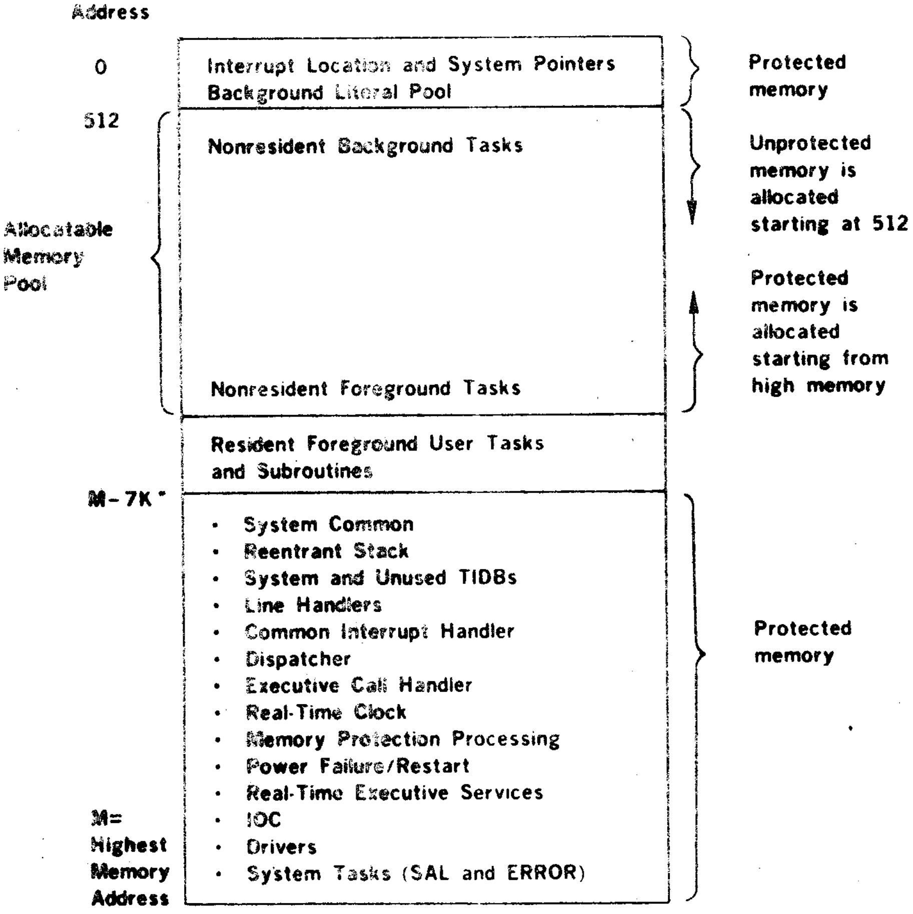
14.2.2 Priorities

Thirty-two priority levels (0 through 31) are provided in the VORTEX system. Levels 2 to 31 are reserved for protected foreground usuage. Level 26 is reserved for SAL2. Level 25 is reserved for the two VORTEX system tasks, SAL and ERROR. Levels 24 and 23 are reserved for I/O drivers. All other foreground levels are available to the user. More than one task per level can be scheduled.

reserved
means
recommended!

Levels 1 and 0 are reserved for tasks running in the background allocatable memory and residing in the background library. Level 1 is reserved for VORTEX system protected tasks, e.g., the job-control processor, the load-module generator, the FORTRAN compiler, the DAS MR assembler, etc. These tasks run with memory protection disabled and can be checkpointed when their space is needed by a foreground task. Level 0 tasks cannot modify or destroy the system (figure 14-3).

Only one background task can be active and in memory at any given time. If other background tasks have been scheduled, the active background task must execute an EXIT service request before the scheduled task(s) can be loaded and executed. If a background task calls EXIT and no tasks are scheduled for the background area, and the requesting task is not the job-control processor, the JCP is scheduled. Otherwise, there is a normal exit.


Address
0
Interrupt Location and System Pointers
Background Literal Pool
Protected memory
512
Nonresident Background Tasks
Unprotected memory is allocated starting at 512
Allocatable Memory Pool
Protected memory is allocated starting from high memory
Nonresident Foreground Tasks
Resident Foreground User Tasks and Subroutines
M-7K*
• System Common
• Reentrant Stack
• System and Unused TIDBs
• Line Handlers
• Common Interrupt Handler
• Dispatcher
• Executive Call Handler
• Real-Time Clock
• Memory Protection Processing
• Power Failure/Restart
• Real-Time Executive Services
• IOC
• Drivers
• System Tasks (SAL and ERROR)
Protected memory
M=
Highest
Memory
Address

If a configuration increases memory, the allocatable memory pool would increase and resident routines would reside in a higher position in memory.

* 7K is enough room for the minimum VORTEX nucleus components, plus four empty TIDB's and three I/O drivers. Users with more I/O devices or a greater number of TIDB's will need more than 8K.

Figure 14-2. VORTEX Memory Map

	Priority Level	
Foreground Priority Levels	31 • • •	
	26	System Task SAL2
	25	VORTEX System Tasks SAL and ERROR
	24	Driver Tasks (Low Speed Devices)
	23	Driver Tasks (High-Speed Devices)
	22 • • • • • 11	
	10	Operator Communication Task
	9 • • • 2	
Background Priority Levels	1	VORTEX System Protected Tasks
	0	User Unprotected Tasks

? shouldn't these be reversed ?

Figure 14-3. VORTEX Priority Structure

Symbol	Word	Bits		
		15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0		
TBTRD	0	Task Thread		
TBST	1	Task Status		
TBPL	2	Task Status	Priority Level	
TBEVNT	3	Interrupt Event		
TBRSA	4	A Register (Reentrant and Suspension Stack)		
TBRSB	5	B Register (Reentrant and Suspension Stack)		
TBRSX	6	X Register (Reentrant and Suspension Stack)		
TBRSP	7	OF	P Register (Reentrant and Suspension Stack)	
TBRSTS	8	Temporary Storage (Reentrant and Suspension Stack)		
TBENTY	9	Task Entry Address		
TBTMS	10	Time Counter - Clock Resolution Increments		
TBTMIN	11	Time Counter - Minute Increments		
TBISA	12	A Register (Interrupt Stack)		
TBISB	13	B Register (Interrupt Stack)		
TBISX	14	X Register (Interrupt Stack)		
TBISP	15	OF	P Register (Interrupt Stack)	
TBISRS	16	Reentrant Stack Address (Interrupt Stack)		
TBIO	17	No. of I/O Requests Threaded	No. of I/O Requests Active	
TBKN1	18	Task Name		
TBKN2	19	Task Name		
TBKN3	20	Task Name		
TBTLC	21	First Address in Allocatable Memory		
TBCPTH	22	Background Task Queue		
TBATSK	23	Address of Scheduling TIDB		
TBRSE	24	Task Error Code		
TBSIZ	25	Task Size	Unused	
TBNUCL	26	Nucleus Module Indicators	Unused	Map Key
TBMING	27	Map Image Address		
TBIST	28	Interrupt Status		
*TBRSR3-TBRSR7	29-33	V75 Registers (reentrant and suspension stack)		
*TBISR3-TBISR7	34-38	V75 Registers (interrupt stack)		

*Words 29 through 38 are present only if the V75 flag was set at SYSGEN and the task had a long TIDB created.

Figure 14-4. TIDB Description

Table 14-2. TIDB Description

Key:

Symbol	**Word**	**Bits**	**Set =**	**Description**
TBTRD	0	15-0	Task thread	Points to next TIDB in chain. V$TB points to the highest-priority active task. Last TIDB on queue has zero in TBTRD.
TBST	1	15-0	Task status	See table 15-5.
TBPL	2	15	Task opened	Bit set when SAL has opened task but not loaded it (memory not available).
		14	Long TIDB	Bit set if V75 SYSGEN and task had a long TIDB created. Ten words are allocated at the end of TIDB to save extra registers.
		13	Load overlay	RTE overlay request made by task with overlay name in user request. 1 = overlay load.
		12	Background checkpoint I/O wait	Foreground task waiting for background I/O to complete so it can be checkpointed to make allocatable memory available. 1 = yes.
		11	Allocation override flag	Overrides bits 9 and 12 of TBPL and bit 5 of TBST. When FNIS routine of SAL releases memory and/or a TIDB, sets bit 11 for tasks having bits 9 and 12 of TBPL and bit 5 of TBST set. SAL then tries to allocate memory; nor scheduler, a TIDB. 1 = override.
		10	Background being checkpointed	Background task being written on checkpoint file. 1 = yes.
		9	TIDB not available	Schedule request made but no TIDBs available for allocation. The task is suspended until one becomes available. 1 = TIDB not available.
		8		Task waiting for available map. 1 = map has been assigned to task.

Table 14-2. TIDB Description *(continued)*

Symbol	Word	Bits	Set =	Description
		7		Task map checkpoint. 1 = task's map has been checkpointed.
		6	Delay type 3 request	Set by RTE when a delay, type 3 request is made. Cleared by IOC upon completion of I/O request.
		5-0	Task priority level	Specifies priority level (0-31) of task to be executed.
TBEVNT	3	15-0	Interrupt event	Matches bits in interrupt-handler calling sequence. Interrupt-handler event inclusively ORed into TIDB word 3 when processed by line handler. If a bit sets while status bits 3 and 14 are set, dispatcher activates task. Clear event word before exiting.
TBRSA	4	15-0	A register (reentrant and suspension stack)	IOC and RTE calls store volatile register contents in this stack (words 4-8).
TBRSB	5	15-0	B register (reentrant and suspension stack)	
TBRSX	6	15-0	X register (reentrant and suspension stack)	
TBRSP	7	15	OF (overflow) register (reentrant and suspension stack)	
		14-0	P register (reentrant and suspension stack)	
TBRSTS	8	15-0	Temporary storage (reentrant and suspension stack)	
TBENTY	9	15-0	Task entry	Absolute address of first executable data of a task.

Table 14-2. TIDB Description *(continued)*

Symbol	Word	Bits	Set =	Description
TBTMS	10	15-0	Time counter (clock resolution increments)	Words 10 and 11 indicate time left before execution. (Clock routine increments both words when bit 6 or 7 is set in status 1.)
TBTMIN	11	15-0	Time counter (minute increments)	
TBISA	12	15-0	A register (interrupt stack)	Words 12-16 store volatile register contents during interrupt by higher-priority task. (Upon reactivation, words 12-16, volatile register contents, and reentrant stack pointer are restored and execution is continued.)
TBISB	13	15-0	B register (interrupt stack)	
TBISX	14	15-0	X register (interrupt stack)	
TBISP	15	15	OF (overflow) register (interrupt stack)	
		14-0	P register (interrupt stack)	
TBISRS	16	15-0	Reentrant stack pointer (interrupt stack)	
TBIO	17	15-8	Number of I/O requests threaded	Incremented by IOC when I/O request is received, and decremented upon completion. (A task cannot exit or abort until counter is zero.)
		7-0	Number of active I/O requests	Incremented by IOC when it sets an I/O driver active, and decremented upon completion.
TBKN1	18	15-0	Task name	First two characters of six-character task name.

Table 14-2. TIDB Description *(continued)*

Symbol	Word	Bits	Set =	Description
TBKN2	19	15-0	Task name	Second two characters of six-character task name.
TBKN3	20	15-0	Task name	Final two characters of six-character task name.
TBTLC	21	15-0	First address in allocatable memory	Points to first address allocated for use by task. After a task has been loaded, SAL save the read-only page number and number of pages in TBTLC as described for TBNUCL, bit 12.
TBCPTH	22	15-0	Background task queue	Any background task waiting to be loaded in background allocatable memory is queued through this word. (A running background task can schedule other background tasks, but cannot load them until space is available.)
TBATSK	23	15-0	Address of scheduling task's TIDB	Stores this address, and upon EXIT or ABORT (if bit 1 of TBST set) reactivates scheduling.
TBRSE	24	15-0	Task error	Upon error, system routines store error codes here and set error status bit (4 of TBST). ERROR routine decodes and prints message.
TBSIZ	25	15-10	Task size	Number of pages of memory to be allocated to task.
		9-0	Reserved for future use	
TBNUCL	26	15-8	Nucleus indicator	Bit 8 reserved for future VORTEX use. Bit 9 wheh set indicates map foreground blank common in task; read-write access mode. Bit 10 when set indicates map nucleus table module in task; priority 0 tasks are mapped with module set to read operand only. All other priority tasks are mapped with the module set to read-write access mode.

Table 14-2. TIDB Description *(continued)*

Symbol	Word	Bits	Set =	Description
				Bit 11 when set indicates map global FCB in task; this module is mapped read-write access mode. Bit 12 when set indicates map pages read-only specified by LMGEN. Read only pages have been designated during load module generation. The logical page number and the number of pages are set in the load module pseudo TIDB and temporarily stored in TBTMIN bits 15-8 and bits 7-0 respectively. After the task is loaded in memory, the page numbers are stored in TBTLC, SAL sets the specified pages to read-only access mode.
		7-4	Reserved for future VORTEX use	
TBKEY	26	3-0	Key	Task map key. This is the map number (0-15) assigned to the task by SAL or SGEN.
TBMIMG	27	15-0	Map image	Address of task map image. This is the map 0 logical address of the task's map image. Normally it would be immediately following the task's TIDB.
TBIST	28	15-0	Interrupt status	Bit 15 is 0 if V$KEY to be set to zero and is 1 if V$KEY to be set to TBIST (bits 3-0). Bits 14-0 are the map status as input from hardware.
TBRSR3	29	15-0	V75 register 3 (reentrant and suspension stack)	IOC and RTE call store volatile register contents in this stack (words 29-34).
TBRSR4	30	15-0	V75 register 4	
TBRSR5	31	15-0	V75 register 5	
TBRSR6	32	15-0	V75 register 6	
TBRSR7	33	15-0	V75 register 7	

Table 14-2. TIDB Description *(continued)*

Symbol	Word	Bits	Set =	Description
TBISR3	34	15-0	V75 register 3	Words 31-35 store volatile register contents during interrupt by higher priority task (see description of TBISA).
TBISR4	35	15-0	V75 register 4	
TBISR5	36	15-0	V75 register 5	
TBISR6	37	15-0	V75 register 6	
TBISR7	38	15-0	V75 register 7	

Table 14-3. Map of Lowest Memory Sector

Address	Symbolic Name	Description
00-01		CPU interrupt code (preset to NOP)
02-015		Unassigned: available to the user
016		Unassigned. Reserved for future VORTEX II use
017		TIDB address for WCS reload task
020,021		Memory protection interrupt: halt (jump-and-mark to V$MPER)
022,023		Memory protection interrupt: I/O (jump-and-mark to V$MP3)
024,025		Memory protection interrupt: write (jump-and-mark to V$MP2)
026,027		Memory protection interrupt: jump (jump-and-mark to V$MAP2)
030,031		Memory protection interrupt: unassigned (jump-and-mark to V$MAP1)
032,033		Memory protection interrupt: instruction fetch (jump-and-mark to V$MAPE)
034,037		Reserved for future VORTEX II use. Jump-and-Mark to V$MPI0 to ignore spurious interrupts
040,041		Power-down interrupt (jump-and-mark to V$PFDN)

Table 14-3. Map of Lowest Memory Sector *(continued)*

Address	Symbolic Name	Description
042,043		Power-up interrupt (jump-and-mark to V$PFUP)
044,045		Variable-interval interrupt address (jump-and-mark to V$CLOK)
046	V$CRDM	Keypunch (0 = 026, 1 = 029): Bit 0 SGEN nominal keypunch Bit 1 Set to 1 (if V75 system) Bit 8 Current keypunch specified by JCP /KPMODE directive (/JOB, /FINI, or /ENDJOB resets the current value to nominal value)
047	V$JCTM	JCP Temporary Storage
050-053	V$JNAM	Eight-character job name
054	V$LCNT	Line count (set by a JCP /FORM directive): used by DAS MR assembler and FORTRAN compiler to determine the number of lines printed before a top of form is issued.
055	V$JCFG	JCP flags: Bits 15-10 Number of extra memory blocks to be allocated with background task (cleared after loading) Bits 9-5 Unused. Bit 4 Dump flag if load and go Bit 3 Dump flag (if set, the background dumps after a normal EXIT or abortion) Bits 2-0 Load-and-go flags
056-067	V$BIC1	BIC in sequence (maximum 8). See section 14.4.6 for a description of VORTEX II use of BICs and BTCs
070-073	V$DATE	Eight-character date set up by OPCOM directive ;DATE,mm/dd/yy
074	V$PLCT	Permanent line count set up at system-generation time
075	V$BGLB	Protection code and logical unit number of the BL unit
076-077		FPP (Floating-Point Processor) interrupt (jump and mark to V$FPP)

Table 14-3. Map of Lowest Memory Sector *(continued)*

Address	Symbolic Name	Description
0100-0117		PIM 0 jump-and-mark to individual line handlers. Unassigned lines are set to JMPM V$MPI0 to ignore spurious interrupts
0120-0137		PIM 1* jump-and-mark to individual line handlers
0140-0157		PIM 2* jump-and-mark to individual line handlers
0160-0177		PIM 3* jump-and-mark to individual line handlers
0200-0217		PIM 4* jump-and-mark to individual line handlers
0220-0237		PIM 5* jump-and-mark to individual line handlers
0240-0257		PIM 6* jump-and-mark to individual line handlers
0260-0277		PIM 7* jump-and-mark to individual line handlers
0300	V$CTL	Address of currently executing task TIDB (0177777 = dispatcher, 037, = real-time clock routine)
0301	V$CPL	Priority level of currently executing task
0302	V$CRS	Address of current reentrant stack (zero if the currently executing task is not executing a reentrant subroutine)
0303	V$TB	Address of highest-priority TIDB in the active stack
0304	V$UTB	Address of dynamically allocated page. If zero, no page yet allocated. This is the top of the thread for pages allocated for dynamic memory allocation as required for TIDB space, I/O request, etc.
0305	V$PTVB	Address of next entry in reentrant stack
0306	V$FLRS	Address of first location of reentrant stack
0307	V$LRSK	Address of last location of reentrant stack + 1
0310	V$CKPT	Checkpoint flag (set if background checkpointed)

Table 14-3. Map of Lowest Memory Sector *(continued)*

Address	**Symbolic Name**	**Description**
0311	V$OPCL	Address of TIDB for OPCOM task
0312	V$LSAL	Address of TIDB for system SAL task
0313	V$LER	Address of TIDB for system ERROR task
0314	V$TJCP	Address of TIDB for JCP task
0315	V$BTB	Address of current active background task TIDB (zero if no background task active)
0316	V$NPAG	Number of available physical pages remaining in V$PAGE for allocation
0317	V$LLUP	Logical address specifying the end of the execution background tasks allocated memory space
0320	V$IM	Interrupt mask for PIM 0 (0 = enable, 1 = disable) (bit 0 = line 0)
0321		Interrupt mask for PIM 1
0322		Interrupt mask for PIM 2
0323		Interrupt mask for PIM 3
0324		Interrupt mask for PIM 4
0325		Interrupt mask for PIM 5
0326		Interrupt mask for PIM 6
0327		Interrupt mask for PIM 7
0330	V$MAP	Map key availability flag word. Bit 0 = map 0, bit 1 = map 1, etc. A zero indicates that the map is unavailable for assignment, a 1 = map is available for assignment
0331	V$BTBM	Base address of nucleus table module. Top of nucleus table module defined by V$GFCB
0332	V$GFCB	Base address of global FCBs
0333	V$MIMG	Map 0 image address

Table 14-3. Map of Lowest Memory Sector *(continued)*

Address	Symbolic Name	Description
0334-0337	VSTO, VST1, V$ST2, V$ST3	FUNCI word for executive mode states 0, 1, 2, 3. Used by map 0 tasks to switch executive mode states. See section 1.3 for description on the use of V$STO-V$ST3. These words are set up by the dispatcher. Bits 0-3 are set to the map number in TBKEY. If the task has been interrupted, the map number in bits 0-3 of TBIST is used
0340	V$KEY	VORTEX currently executing map key
0341	V$CRDR	Address of resident directory. See section 14.4.8
0342	V$TBGT	Top of thread of background tasks waiting for allocation
0343	V$TMS	Time-of-day in 5-millisecond increments (fractions of a minute stored in this word; upon reaching 1-minute V$TMN increments, V$TMS resets). The range is 0 to 12000.
0344	V$TMN	Time-of-day in minutes (full minutes up to 24 hours stored in this word; upon reaching 24 hours (24 x 60 minutes). V$TMN resets). The range is 0 to 1440.
0345	V$LUNT	Address of logical-unit name table
0346	V$OPCF	OPCOM lockout flag (busy)
0347	V$FGLB	Protection code and logical-unit number of the FL unit
0350	V$FREE	Reserved for future VORTEX use
0351	V$CTMS	Clock resolution in 5-millisecond increments (user-specified millisecond interrupt rate/5) specified at system-generation time
0352	V$SCV	Selected clock count (1 to 4095) ([user-specified millisecond interrupt rate] x [1000/V$CKB])
0353	V$LPP	Pointer to last tested word in V$PAGE
0354	V$CRM	Clock resolution increments for fractions of a minute in 5-millisecond increments
0355	V$DSTB	Address of DST block

Table 14-3. Map of Lowest Memory Sector *(continued)*

Address	Symbolic Name	Description
0356	V$LIT	Last address in background literal pool
0357	V$PGT	Address of V$PAGE, physical page availability mask.
0360	V$CTAD	Base address for controller address table
0361	V$SCTL	Current controller in scan
0362	V$NCTR	Number of controllers
0363-0372	V$PIMN	External device address table for PIMs
0373-0374	JUMP V$IOST	VORTEX II link for IOC STAT CALL
0375	V$SLFG	System SAL task busy flag (1 = busy)
0376	V$ERFG	Error task busy flag (1 = busy)
0377	V$JOP	JCP operating flag (1 = busy)
0400	V$LUT1	Starting address of logical-unit table for JCP/OPCOM-assignable logical units (1 - 100)
0401	V$LUT2	Starting address of logical-unit table for unreassignable logical units (101-179)
0402	V$LUT3	Starting address of logical-unit table for OPCOM-assignable logical units (180-255)
0403	V$1MIN	Clock constant set up by SGEN where V$1MIN = 32767 - (60000/(5*V$CTMS)) + 1
0404-0405	JUMP V$IOC	VORTEX II link to IOC
0406,0407	JUMP V$EXEC	VORTEX II link to RTE
0410	V$IOA	I/O algorithm
0411	V$CKIT	Clock interrupted PIM before it could be locked out (common interrupt handler and clock-processor flag)
0412	V$JCB	Address of 41-word JCP buffer (all system background programs and JCP input directives into this sytem buffer)

Table 14-3. Map of Lowest Memory Sector *(continued)*

Address	Symbolic Name	Description
0413	V$OCB	Address of 41-word OPCOM buffer (OPCOM reads operator key-in requests into this buffer; if JCP is not active and a slash record is read, OPCOM moves the directive to V$JCB before scheduling JCP)
0414	V$BVN	Bottom of VORTEX nucleus. SGEN sets to virtual address. Initializer sets to page number
0415	V$BFC	Bottom of foreground blank common
0416	V$TFC	Top of foreground blank common, top of VORTEX nucleus core
0417	V$PST	Maximum RMD partitions per unit in system
0420	ZERO	Zero word
0421	BS0	Bit mask contents 0000001
0422	BS1	Bit mask contents 0000002
0423	BS2	Bit mask contents 0000004
0424	BS3	Bit mask contents 0000010
0425	BS4	Bit mask contents 0000020
0426	BS5	Bit mask contents 0000040
0427	BS6	Bit mask contents 0000100
0430	BS7	Bit mask contents 0000200
0431	BS8	Bit mask contents 0000400
0432	BS9	Bit mask contents 0001000
0433	BS10	Bit mask contents 0002000
0434	BS11	Bit mask contents 0004000
0435	BS12	Bit mask contents 0010000
0436	BS13	Bit mask contents 0020000
0437	BS14	Bit mask contents 0040000
0440	BS15	Bit mask contents 0100000
0441	BR0	Bit mask contents 0177776
0442	BR1	Bit mask contents 0177775
0443	BR2	Bit mask contents 0177773

Table 14-3. Map of Lowest Memory Sector *(continued)*

Address	Symbolic Name	Description
0444	BR3	Bit mask contents 0177767
0445	BR4	Bit mask contents 0177757
0446	BR5	Bit mask contents 0177737
0447	BR6	Bit mask contents 0177677
0450	BR7	Bit mask contents 0177577
0451	BR8	Bit mask contents 0177377
0452	BR9	Bit mask contents 0176777
0453	BR10	Bit mask contents 0175777
0454	BR11	Bit mask contents 0173777
0455	BR12	Bit mask contents 0167777
0456	BR13	Bit mask contents 0157777
0457	BR14	Bit mask contents 0137777
0460	BR15	Bit mask contents 0077777
0461	NEG	Bit mask contents 0177777
0462	LHW	Left-half word mask (0177400)
0463	RHW	Right-half word mask (0000377)
0464	THREE	Data word (000003)
0465	FIVE	Data word (000005)
0466	SIX	Data word (000006)
0467	SEVEN	Data word (000007)
0470	NINE	Data word (000011)
0471	TEN	Data word (000012)
0472	BM17	Bit mask word (000017)
0473	BM37	Bit mask word (000037)
0474	BM77	Bit mask word (000077)
0475	BM177	Bit mask word (000177)
0476	BM777	Bit mask word (000777)
0477	BM1777	Bit mask word (001777)
0500-0777		Background literals and pointers

14.2.3 Timing Considerations (Approximate)

Real-time clock interrupt processor: At each incrementation of the real-time clock, there is a TIDB service scan requiring

$$x + 8y + 7z \text{ cycles}$$

where

x is 48 when the scan interrupts the dispatcher, or 63 when it interrupts a task and must establish a reentrant stack and store the contents of the volatile registers

y is the number of TIDBs searched

z is the number of tasks having time- or schedule-delay status bits set

The clock interrupt is disabled during the execution of the clock processor, and PIM interrupts are disabled for 26 cycles following the initial entry of the clock processor.

Dispatcher interrupt processor: The time required to begin execution of a task through the dispatcher is a function of the number of TIDBs searched before execution. The time required to begin execution of the nth task is

$$t + 14u + 17v + 12w + 18x + 25y + z$$

where

t is 17 or 25, depending on the entry to the dispatcher

u is the number of tasks with task-suspended bits (TBST bit 14) set

v is the number of tasks with events expected but event word reset

w is the number of tasks with error bits (TBST bit 4) set but error task busy

x is the number of tasks with either task-aborted (TBST bit 13) or task-exited (TBST bit 12) set but I/O not completed

y is the number of tasks active but not loaded

z is one of the following values:

107 to activate the ERROR task
110 to activate the SAL task on aborting or exiting
114 to activate a loaded task that is not suspended, or to activate the SAL task to load the requested task
104 to activate an interrupted, suspended task
62 to activate a task when the event word is set and the interrupt suspended

Search, allocate, and load:

Load processing requires, for a foreground task

$$852(k) + v(k) + w(k) + x + y + ny$$

where

k is the cycle time

v is the nucleus module required by the task and is 28 + A + B + C cycles

where

A is 28 + 8 times the size of common, in pages
B is 81 cycles as an average for the nucleus table module
C is 11 + 11 times the number of specified read-only pages

x is the time to process an OPEN request

y is the time to read an RMD record (pseudo TIDB)

ny is the time to read a task from RMD into memory (variable depending on RMD device and task size)

w is the page allocation 45 + 35 times the task size, in pages

For a background task, load processing requires

$$945(k) + v(k) + w(k) + x + y + ny$$

where

k is the cycle time

w is the page allocation and is 45 + 35 times the task size, in pages

v nucleus module required by task and is 28 + A + B + C

where

A is 53 cycles (global FCB module)
B is 81 cycles (average, nucleus table module)
C is 11 + 11 times the number of specified read-only pages

x, y and ny are as defined for foreground task.

Resident task load processing requires

$$(533 + 9(x) + y)k$$

where

k is the cycle time

x is the task size, in pages

y is the nucleus module required by task
48 + A + B + C + D

where

A is 28 + 8 times the size of common, in pages
B is 53 cycles for global FCB
C is 81 cycles for nucleus table module
D is 11 + 11 times the number of read-only pages

14.3 REENTRANT SUBROUTINES

The user can write a reentrant subroutine and add it to the VORTEX nucleus. RTE service requests ALOC and DEALOC interface between a task and a reentrant subroutine.

A task calls a reentrant subroutine via an ALOC request that allocates a variable-length push-down reentrant stack with the external name V$CRS. The reentrant subroutine address is specified in the ALOC calling sequence. The first word of the reentrant subroutine contains the number of words to be allocated.

A reentrant stack generated by the ALOC request has the format:

Word		
V$CRS —— 0	A Register	Fixed Size
1	B Register	
2	X Register	
3	OF | P Register	
4	Pointer to Previous Reentrant Stack	
5	Available for Reentrant Subroutines	Fixed Size
.	.	
.	.	
.	.	
n	.	
n + 1 to n + 5	V75 Registers 3-7	

When writing a reentrant subroutine, ensure that the entry location contains the number (≥5) of words to be allocated, execution starts at the address (entry address + 1), and that V$CRS contains the reentrant-stack address. No IOC or RTE calls except DEALOC can be made while in a reentrant subroutine. The subroutine makes a DEALOC service request to return control to the calling task. DEALOC releases the reentrant stack, restores the A, B, and OF register contents, and returns control to the address following the ALOC request. No temporary storage is available for the reentrant subroutine except that allocated in the reentrant stack.

V$CRS must be set by ALOC

PX lost

Parameters or pointers can be passed to the reentrant subroutine in the A and/or B (and V75 if present) registers, as well as in-line after the ALOC macro.

Two tasks make ALOC calls to RSUB. RSUB reserves six words of allocatable memory with the sixth word as temporary storage. The A register (reentrant stack) returns a value to the calling task. If task A is on priority level 5 and task B is on level 6, RSUB running on level 5 is interrupted and the level 6 task B executed. This, in turn, makes an ALOC request and executes RSUB. RSUB then executes to completion before RSUB on level 5 can be completed.

Example: ALOCATE and CALL

Task A

```
        ALOC    RSUB
        JAZ     ----
        .
        .
        .
        END
```

Task B

```
        ALOC    RSUB
        JAZ     ----
        .
        .
        .
        END
```

RX has [illegible] value [illegible]

Reentrant Subroutine

```
        NAME    RSUB
V$CRS   EQU     0302
RSUB    DATA    6         Allocate six-word
        LDX     V$CRS     Stack (one temporary
                          location)
        .
        .
        .
        STA     5, 1      Save A in temporary
                          storage
        .
        .
        .
        LDA     5, 1      Get temporary storage
                          value
        .
        .
        .
        STA     0,1       Modify return in A
                          register
        .
        .
        .
        DEALOC            Return to location
                          following ALOC call
        .
        .
        .
        END
```

dealocate and return

14.4 CODING AN I/O DRIVER

The IOC (section 3) activates I/O drivers. When a user task makes an I/O request, it executes a JSR 0404,X instruction. IOC then makes validity checks on the parameters specified in the request block (RQBLK) that immediately follows the JSR instruction. IOC queues RQBLK to the I/O driver controller table (CTBL), and activates the corresponding controller-table TIDB. The TIDB contains the entry address for the I/O driver. To determine the proper CTBL and corresponding TIDB, IOC obtains the logical-unit number from RQBLK. By referring to the logical-unit table (LUT), IOC then finds the device assigned to that logical unit. Each device has a device specification table (DST) associated with it, and each DST has a corresponding controller table.

In VORTEX all RQBLKs are moved to map 0 dynamically allocable space. Upon completion of the I/O request, IOC moves the RQBLK to the requesting task's logical memory.

14.4.1 I/O Tables

Not all the data discussed in this section are required for coding every special-purpose driver, but it is presented to provide maximum flexibility in defining driver interfaces.

When an I/O driver is entered, it has the data, system pointers, and table address necessary for the I/O driver processing. At system-generation time, additional working storage space can be assigned to the I/O driver as an extension of the controller table. The data available are:

a. V$CTL (lower-memory system symbol defining the current TIDB) = address of TIDB associated with the I/O driver controller table.

b. TBRSTS (word 8 of controller TIDB) = address of controller table CTBL.

c. Within CTBL, the following:
(1) CTIDB (word 0) = controller TIDB address (V$CTL)
(2) CTDST (word 3) = address of DST
(3) CTRQBK (word 4) = address of RQBLK to be processed
(4) CTDVAT (word 6) = controller device address
(5) CTSTAT (word 8) = temporary storage available for driver
(6) CTBICB (word 9) = address containing assigned BIC address (e.g., 020,022)
(7) CTFCB (word 10) = FCB or DCB address for I/O request specified in CTRQBK (word 4)
(8) CTWDS (word 11) = contains, upon exit, number of words transferred
(9) CTSTSZ (word 13) = number of words per RMD sector
(10) CTTKSZ (word 14) = number of sectors per RMD track
(11) CTPST0 (word 15) = base address of the RMD for unit 0 on this controller
(12) CTPST1, CTPST2, and CTPST3 (words 16, 17, and 18) = PST addresses for units 1, 2, and 3

d. Device specification table (DST):
(1) DSUNTN (bits 13 and 14 of word 2) = number (0-3) of this device on its controller
(2) DSPSTI (bits 6-10 of word 2) = RMD partition number (1-20) used to access the PST

e. Request block (RQBLK): Contains user task I/O request information. The address of RQBLK is contained in CTRQBK (word 4 of the controller table). Word 1 of RQBLK contains the operation code in bits 8-11 and the mode specification in bits 12-14. Word 0 bits 5-14 contain the status.

f. File control block (FCB): The FCB is used for RMD devices. CTFCB contains the address of FCB.
(1) FCRECL (word 0) = record length
(2) FCBUFF (word 1) = user buffer
(3) FCACM (word 2) = bits 8-15, access method, and bits 0-7, protection code
(4) FCCADR (word 3) = current record number (relative within file)
(5) FCCEOF (word 4) = current EOF record number (relative within partition)

(6) FCIFE (word 5) = beginning-of-file record number (relative within partition)
(7) FCEFE (word 6) = end-of-file record number (relative within partition)
(8) FCNAM1, FCNAM2, and FCNAM3 (words 7, 8, and 9) = file names in ASCII

g. Data control block (DCB): The DCB is used for non-RMD devices. CTFCB contains the address of DCB.
(1) DCRECL (word 0) = record length
(2) DCBUFF (word 1) = user buffer
(3) DCCNT (word 2) = function count

h. V$CTL, TIDB, CTBL, DST, and the RQBLK reside in map 0. The FCB and DCB reside in the user's logical memory and to access the data, the I/O,drivers must switch to the proper executive mode state (see section 1.3).

14.4.2 I/O Driver System Functions

Each I/O driver under IOC performs certain system pre- and post- processing functions.

Pre-interrupt processing: The I/O driver must switch executive mode states to fetch or store data from user mode (see section 1.3). If the I/O driver uses a BIC, the driver calls V$BIC with the X and A registers set to the initial and final buffer addresses respectively to build and execute the initial BIC transfer instruction. If the BIC is shared, the interrupt line handler is modified to the proper interrupt event word setting (TBEVNT) and TIDB address. V$BIC performs this modification if the word immediately following the call (JSR V$BIC,B) is nonzero, since this is assumed to be the interrupt event word setting. If it is zero, no line handler modification is performed. The I/O driver clears the interrupt event word (TBEVNT) in the controller TIDB immediately preceding a DELAY (type 2) call. To wait for an interrupt, the I/O driver executes a DELAY (type 2) call with a time-out. The return to the driver, either from a time-out or interrupt is to the address immediately following the call. The contents of the X register is not restored following a DELAY call but the A and B registers are. Executing a TXA immediately preceding and a TAX following the DELAY call X restores the value in the X register.

Interrupt processing: The driver clears the time-delay flag (TBST bit 6) set by the DELAY call, and checks TBEVNT to determine if an interrupt occurred (TBEVNT = 0 indicates a time-out). Following the interrupt processing, the driver clears TBEVNT and calls DELAY (type 2) for the next instruction.

Post-interrupt processing (no errors): Upon the completion of interrupt processing, the driver sets the status bits (5-14) of RSTPR (word 0) in RQBLK, and enters the number of words transferred in CTWDS. The driver then relinquishes control and exits to IOC by executing JMP V$FNR.

Post-interrupt processing (errors): If an error is encountered during interrupt processing, the driver sets the status bits (5-14) of RSTPR, according to the type of error. The driver then sets the A register to zero if the unit is not ready, negative if there is a parameter error, or positive if there is a hardware error. Finally, the driver exits to the IOC error routine by executing JMP V$ERR.

14.4.3 Adding an I/O Driver to the System File

System-generation directives: The following directives are required for linkages to the controller table, controller TIDB, I/O driver entry location, DST, PST, and the PIM line handler (section 15):

Directive	Description
EQP	DSTs are generated by SGEN, one for each unit specified by the EQP directive. All DSTs generated for a controller point indirectly to the controller table specified by EQP. The pointer is to the entry name in the controller table assembly.
PIM	A PIM directive is required for each PIM line where an interrupt is expected. The PIM directive causes the system initializer to enable the mask for that line (except for the TTY or CRT output line, in which case it is initially disabled). If the driver processes both input and output interrupts, it may be advantageous for processing to set the interrupt event word for the input line to one value (e.g., 01) and the interrupt event word for the output line to another value (e.g., 02). The PIM directive also specifies if a directly connected interrupt handler is to be used (see section 14.4.5).
ASN	This directive assigns logical units to physical units. If a new device is being added and it is necessary to assign that device to a logical unit when the system is initialized, an ASN is input. Otherwise, the JCP or OPCOM ASSIGN directive can be used. The logical-unit table is established by these directives.
PRT	This directive for RMDs specifies the size and the mnemonic name of each partition. A PST and DST are created for each partition.
TDF	This VORTEX nucleus-generation control record directive defines and builds the controller TIDB. It specifies the name of the driver, status word (TBST) setting, and priority level.

Adding controller tables: A controller table is assembled as a separate entity and added to the system-generation library (SGL) for loading at system-generation time. The controller table name is CT followed by the three- or four-character ASCII name of the controller, e.g., CTTY0A, CTMT0A, and CTD0B.

VORTEX Input/Output Control (IOC) assumes the first 13 words of all non-RMD controller tables to be identical, i.e., word 0 = CTIDB; word 1 = CTADNC, etc. For RMDs the first 18 words are assumed to be identical. Additional words may be added to the controller table by for use by the individual I/O driver.

The controller table comprises parameters that are constant for a controller, and parameters that are variables for SGEN and can change with system configuration.

Constants are assembled as DATA statements. DATA statements can be added to the controller table to provide additional working space for an I/O driver.

The following standard items are required by IOC:

Word Item Description

0 **CTIDB** = Name of the related controller TIDB (TB followed by the same three or four-character name used in the controller table e.g.,. TBD0B (for CTD0B). An EXT statement must specify the TIDB name as an external name.

```
EXT   TBD0B
DATA  TBD0B
```

1 **CTADNC** = This word is used by IOC as temporary storage.

2 **CTOPM** = The operation code mask specifying the type of I/O operation the driver is capable of processing 1 = driver is capable of processing.

Bit	Operation
0	Read
1	Write
2	Write EOF
3	Rewind
4	Skip record
5	Function
6	Open
7	Close
8-16	Reserved for future use

Example: DATA 037
For all operations excluding Function, Open, and Close.

3 **CTDST** = Set by IOC to DST address
Example: DATA 0

4 **CTRQBK** = Set by IOC to I/O request block being processed.
Example: DATA 0

5 **CTRTRY** = Error retry count. #T followed by the name of the controller.

```
Example: DATA     #TTY0A
         EXT      #TTY0A
```

6 **CTDVAD** = Controller device address. #A followed by the name of the controller

```
Example: DATA     #ATY0A
         EXT      #ATY0A
```

7 **CTIOA** = I/O algorithm. The ratio of device transfer rate to DMA transfer rate + 10 percent of the result times 32767. Zero for all non-BIC devices.

Example: when a disc transfer rate is 100K words per second and DMA rate is 300K words per second, the ratio is about .33. Set CTIOA to: DATA 030000
If ratio is .25 or 25 percent set CTIOA (DATA 020000); 50 percent set CTIOA (DATA 040000), etc.
To make CTIOA a SGEN selectable parameter (refer to section 15.5.2, EQP directive) assemble as an external e.g., EXT #D followed by the name of the controller:

```
EXT       #DCIOA          for process I/O
DATA      #DCIOA
```

8 **CTSTAT** = DATA 0, for driver use.

9 **CTBICB** = Address of BIC flag table. B followed by the name of the name of controller,

```
Example: DATA     !BD0B
         EXT      !BD0B
```

When the driver is entered the item points to a call containing the BIC device address, 020, 022, 024, etc.

10 **CTFCB** = Set by IOC to the DCB or FCB address. Set to DATA 0

11 **CTWDS** = DATA 0. Driver use for number of words transferred.

12 **CTFRCT** = I/O algorithm frequency count. The number of retires to be attempted by IOC before suspending all subsequent I/O operations until the request in CTRQBK (word 4) is activated. DATA 0 for non-BIC devices.

13 **CTSTSZ** = RMD only. Number of words in an RMD sector.
Example: DATA 120

14 **CTTKSZ** = RMD only. Number of sectors in an RMD track
Example: DATA 48

15 **CTPST0** = RMD only. Base address of the PST for RMD unit 0 connect to this controller. P followed by the four character device name.

```
Example: DATA     !PD00B
         EXT      !PD00B
```

16 **CTPST1** = RMD only. Base address of the PST for RMD unit 1.

```
Example: DATA     !PD01B
         EXT      !PD01B
```

17 **CTPST2** = RMD only. Base address of PST for RMD unit 2.

```
Example: DATA     !PD02B
         EXT      !PD02B
```

18 **CTPST3** = RMD only. Base address of PST for RMD unit 3.

```
Example: DATA     !PD03B
         EXT      !PD03B
```

14.4.4 Enabling and Disabling PIM Interrupts

The disable and enable PIMs and RT clock instructions (EXC 0147, EXC 0747, EXC 0244, EXC 0444) are privileged instructions and cannot be executed in a user map (non-map 0) without creating a memory protect interrupt. The memory protect processor recognizes the interrupts caused by the disable/enable instructions and returns to the foreground task in the proper disabled or enabled state. The following restrictions apply:

a. Only foreground tasks are permitted to execute the disable/enable PIMs and RT clock instructions. EX21 error message is output of a background task attempts to execute those instructions.

b. The return to the foreground task is at location n + 2. In other words, both the disable PIMs and clock instructions (EXC 0747, EXC 0444 or vice versa) or enable PIMs and clock instructions (EXC 0147, EXC 0244 or vice versa) must be together. The second EXC instruction is not executed.

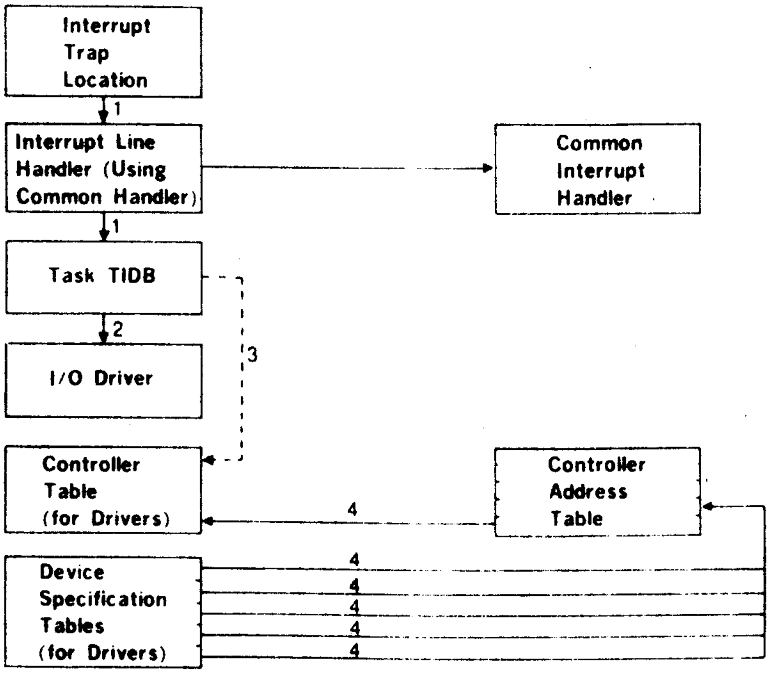
Example:

Location	Instruction	
n	EXC 0444	Disable RT clock instruction creates interrupt.
n+1	EXC 0747	This instruction is not executed.
n+2	•	Return location from the memory protect processor with PIMs and RT clock disabled.

EXC 0444 disables all PIM interrupts. EXC 0244 enables all PIM interrupts · that are not masked. There is a PIM directive for each PIM line at system-generation time. The system initializer enables PIM lines. The mask is enabled unless the I/O driver specifically disables it. If a PIM directive is omitted, the linkage between the trap and the interrupt line handler cannot be established. If a PIM line mask is enabled or disabled by a driver, the system mask is updated to reflect the current status. The system mask configuration is given at low memory address V$IM (0320 for PIM1, 0321 for PIM2, etc.).

EXC 0747 disables the real-time clock interrupt and EXC 0147 enables it.

Figure 14-5 shows the standard VORTEX driver interface.


Interrupt Trap Location
1
Interrupt Line Handler (Using Common Handler)
Common Interrupt Handler
1
Task TIDB
2
3
I/O Driver
Controller Table (for Drivers)
Controller Address Table
4
Device Specification Tables (for Drivers)
4
4
4
4
4

KEY:

1. The trap address corresponding to the PIM number (from PIM directive) points to the SGEN-generated line handler. The line handler points to the TIDB (named in PIM directive), using the matching TIDB name (on TDF control record).
2. The TIDB name (on TDF control record) points to the task, using the entry name in the assembly of the task.
3. *For OPCOM device drivers only.* The task TIDB points to the device controller table name (on TDF control record), using the entry name in the controller table assembly.
4. The DSTs are generated by SGEN, one for each unit specified on the EQP directive. All DSTs generated for a controller point indirectly to the controller table (named in EQP directive), using the entry in the controller table assembly.

Figure 14-5. Driver Interface

14.4.5 Directly Connected Interrupt Handler

VORTEX provides a user two options of specifying directly connected interrupt handlers. The use of a directly connected interrupt handler, in lieu of the VORTEX common interrupt handler, is specified on the PIM directive during system generation (section 15.5.11). The interrupt handlers must be resident in executive mode, map 0.

Option 1 (specifying 1 as the s(n) parameter on the PIM directive) requires the user to:

a. Save and restore the overflow indicator and all volatile registers used by the directly connected interrupt routine before returning to the interrupted task.

b. Not allow ICC and RTE calls.

c. Minimize execution time.

d. Continue to lockout interrupts during processing, then enable the PIMs upon exiting. The RT clock is enabled in all cases except when the real time clock processor has been interrupted. Location 0300, V$CTL, will contain 037 if the RT clock processor had been interrupted. The interrupt handler must provide a check for interruption out of the RT clock processor and enable or disable the RT clock accordingly.

e. Restore the VORTEX system to the proper pre-interrupted state, executive or user mode. Any interrupt forces the system to executive mode, state 0 (see table 1-1). The interrupt handler must return to the proper state. V$KEY, location 0340, contains the map key number of the interrupted task. If the interrupt task is the user mode (1 ≤ V$KEY ≤ 15), the switch from "executive to user mode enable" instruction (EXC2 0246) must be executed. The "clear executive mode state mask" instruction (EXC2 0546) must also be executed.

Example:

```
        •
        •
        •
        LDB     D5000
        LDA     0300      Check location 0300
        SUB     0473      System constant = 037
        JAZ     DIH10     Zero = interrupt out of
        LDBI    0104546   RT clock
        LDAI    0100147   Otherwise enable clock
        JMP     DIH10+1
DIH10   LDA     D5000     = 5000
        STA     DIH30     Enable clock instruction
        STB     DIH30+1   Enable mask instruction
        ROF
        LDA     ROV       Restore overflow
        JANZ    *+3
        SOF
        LDB     D5000     NOP instruction
        LDA     0340      V$KEY check interrupts
        ANA     0472      Task map key
        JAZ     DIH20     0 = map 0
        LDB     0104246   Switch to user map
DIH20   STB     DIH30+2
        LDB     RB        Now restore A, B, X
        LDX     RX
        LDA     RA
        EXC     0244      Enable PIM
DIH30   EXC     0147      Modified to enable clock
                          or NOP
        EXC2    0546      Modified to clear mask
        EXC2    0246      Modified to switch to
                          user map
        EXC2    0646      Enabled memory protect
        JMP     *         Modified to return
                          address
D5000   DATA    05000
```

f. Obtain the interrupted task return address. The directly connected interrupt line handler is entered via a JMPM instruction from the line handler (see figure 14-1) and as such the first word in the interrupt handler must be a mark location. The return address of the interrupted task is found in word 0 of the line handler, which is obtained by subtracting four from the contents of the interrupt handler's mark location.

Option 2 (specifying 2 as the s(n) parameter on the PIM directive) permits the user to use system routines to save (V$DHD) the volatile registers and overflow indicator and restore (V$DRTN) the volatile registers, overflow indicator, and reset the system to the proper pre-interrupted state as described above. Option 2 relieves the directly connected interrupt handler of the housekeeping chores. The A, B, X registers, overflow indicator are saved, PIM and clock interrupts are disabled prior to entering the user code (via JMPM), (see figure 14-1). The user code is entered with the A register set to the TBEVNT value and the X register set to the user code entry address.

Upon completion of processing, the directly connected interrupt handler exits to system routine, V$DRTN.

Example:

```
        NAME    TASK
TASK    ENTR
        STA     EVNT        Save TBEVNT word
        •                 Do processing
        •                 •
        •                 •
        EXT     V$DRTN
        JMP     V$DRTN      Exit to common
                            processor
```

where task must be specified on SGEN PIM directive, e.g., PIM,010,TASK,01,2.

14.4.6 VORTEX Use of BICs and BTCs

VORTEX supports a maximum of 15 BICs or BTCs. The practical system limit may be considerably less than ten depending on the availability of device addresses, the type and number of peripherals, and other configuration considerations. The BIC or BTC transfer complete interrupts must be assigned by ascending BIC or BTC numbers (020, 022, 024, 026, 070, 072, etc.) starting with the first PIM and the first interrupt i.e., PIM 0, line 0 assigned to BIC 020; PIM 0, line 1 assigned to BIC 022, etc. The first BIC must have a device address of 020; the second, 022; the third, 024; the fourth, 026; the fifth, 070; the sixth, 072; etc. Unless the special DEF control directive is used.

I/O drivers utilizing BICs or BTC must call the common BIC routine V$BIC. The X register is set to the initial buffer address and the A register set to the final buffer address. The call to V$BIC is:

```
JSR     V$BIC,B
DATA                 Interrupt event word or 0 if no
                     line handler modification to be
                     performed.
DATA                 Map number
```

14.4.7 VORTEX II and VORTEX Compatibility

User programs written to operate under VORTEX will be operable under VORTEX II under the following conditions:

a. Programs which contain any RTE service requests or Input/Output Control requests must be assembled by the VORTEX II version of DAS MR. Any program which builds these requests without the DAS MR macros must be modified so that the requests conform to the VORTEX II calling sequence.

b. Any foreground task which executes hardware I/O instructions except disabling and/or enabling PIMs and RT clock, see section 14.4.4, must be included as part of the resident nucleus when the system is generated. Foreground library tasks which are made resident during system generation by use of the TSK directive are not considered nucleus tasks and therefore must not contain any hardware I/O instructions (see section 14.4.8 for discussion on resident tasks).

c. Intertask communications can be accomplished: through the use of foreground blank common; by establishing named tables and buffers in the nucleus table module and referencing the named block by an external statement; by use of the RTE PASS request between a user map and map 0; by switching executive mode states (see section 1.3); by sharing the same physical pages utilizing the MAPIN and/or PAGNUM RTE requests.

d. User tasks (except priority 1 system tasks) may not write into or execute instruction from the first physical page. This page is the VORTEX II low memory area. It is mapped as read-operand only into all user tasks (see figure 2-2), except priority 1 tasks where page 0 is mapped as read-write access mode.

e. User tasks (non-nucleus) must not communicate with the nucleus except through the use of standard executive service and I/O requests or by referencing entry points which are contained in the core-resident library.

f. A user task can request a transfer of a block of data from map 0 to the user may by executing a RTE PASS request.

g. Direct connect interrupt handlers must restore the system to the pre-interrupted map state after servicing the interrupt. An alternative is to utilize the SGEN PIM directive, option 2, as described in section 14.4.5.

h. I/O drivers written for VORTEX operation must be modified for VORTEX II as follows:
1. The map number must be passed when calling V$BIC, common BIC/BTC routine (see section 14.4.6).
2. The I/O drivers must switch executive mode states (see section 1.3) to fetch/store data from a user map (DCB, FCB, buffer). RQBLK data are stored in map 0 by dynamic memory allocation.
3. Rotating memory device (RMD) drivers must determine if a data transfer (read, write) I/O request is by SAL (search-allocated-load task). If it is a SAL request, the map number is obtained from TBEVNT of the TIDB for SAL. Otherwise, the requestor's map number is obtained from TBKEY. SAL is the RTE component which loads non- resident tasks into memory. The check may be accomplished as follows:

```
        LDA     RTIDB,B     RTIDB - word 4 of RQBLK
        SUB     V$LSAL      V$LSAL - location 0312 - SAL TIDB
        JANZ    XXX         Jump if not SAL
        LDB     V$LSAL      Yes SAL. Get map key
        LDA     TBEVNT, B   From TBEVNT
        JMP     YYY         Now common processing
XXX     LDB     RTIDB,B     I/O request not by SAL
        LDA     TBKEY,B     Get map key from TBKEY
YYY     ANA     BM17        Mask bits 4-0
```

4. Following a BIC transfer complete interrupt the I/O driver sense for a map memory protection I/O data transfer error:

```
        SEN        0101+da,er
```

where da is the BIC device address (which is found in word 011 of the controller table), and er is the address of the error processing routine which must set up an I046 error code prior to calling V$ERR.

i. If a user wants to fetch/store from the nucleus tables, the user must ensure that the nucleus table module is mapped into the user's logical memory. He does this through an external reference to a symbol, TIDB, controller table, etc., within the nucleus module. Example -- have an "EXT TBTYOA."

j. TIDBs for non-resident tasks -- except JCP and OPCOM -- are dynamically allocated in map 0. Hence a foreground user task cannot load a register (B,X) from location 0300 (V$CTL or an address from any other low-core location) and directly fetch the TIDB data. In VORTEX, it is possible; in VORTEX II, such an attempt would result in a memory protect interrupt. The foreground user can fetch the TIDB data by use of the PASS macro. Except for clearing the TBEVNT word, via the RTE TBEVNT request, a foreground user task cannot modify the TIDB.

14.4.8 Resident Tasks

The VORTEX II user may specify two types of resident tasks during system generation; user mode resident tasks; and executive mode map 0 resident tasks.

a. User mode resident tasks. These tasks are foreground library tasks that are made resident via the SGEN TSK directive. These tasks execute as user mode tasks and cannot execute any I/O type instructions except enable/disable PIMs and RT clock. They reside in memory and may be scheduled via OPCOM or RTE SCHED requests specifying LUN = 0. As these tasks do not reside in map 0 virtual memory, the dynamically allocated space (see figure 1.2) is not reduced as it would be for the executive mode map 0 resident tasks. These resident tasks are defined in the resident directory specified by V$CRDR (0341). Each entry in the directory is as follows:

Word/Bit	15 14 13 12 11 10 9	8 7 6 5 4 3 2 1 0
0	Task Name, first two characters	
1	Task Name, second two characters	
2	Task Name, third two characters	
3	Entry Point	
4	Starting physical page number	
5	Number of pages	
6	Nucleus module indicator	Reserved for future use

b. Executive mode, map 0 resident tasks. These tasks reside in the nucleus program module in map 0. No special SGEN directive is required to include these tasks as part of the nucleus. The VORTEX II user specifies the generation of these resident tasks by adding the program object modules on the SGL between the CTL,21 and CTL,PART3 control records (see figure 15-2). The program name should not start with the characters "VZ--" as these are reserved for I/O drivers. SGEN processes I/O drivers selectively and ignores all I/O driver object modules unless a SGEN EQP directive specified the corresponding peripheral. These executive mode resident tasks: (1) are permitted to execute I/O type instructions; (2) cannot normally be scheduled via the OPCOM or RTE SCHED request, but are activated by resetting bit 14 of the TIDB status word TBST (table 15-5) as are the I/O drivers and SAL; (3) must have a resident TIDB created by a SGEN TDF directive. An alternate means of executing these tasks is via an OPCOM RESUME request. However, caution must be exercised as the RESUME request activates the highest priority task with a matching name.

SECTION 15
SYSTEM GENERATION

The VORTEX **system-generation component (SGEN)** tailors the VORTEX operating system to specific user requirements. SGEN is a collection of program on magnetic tape, punched cards, or disc pack. It includes all programs (except the key-in loader, section 15.3) for generating an operating VORTEX system on an RMD.

Figure 15-1 is a block diagram of the data flow through SGEN.

15.1 ORGANIZATION

SGEN is a five-phase component comprising:

- I/O interrogation (section 15.4)
- SGEN directive processing (section 15.5)
- Building the VORTEX nucleus (section 15.6)
- Building the library (section 15.7)
- Resident-task configuration

I/O interrogation specifies the peripherals to:

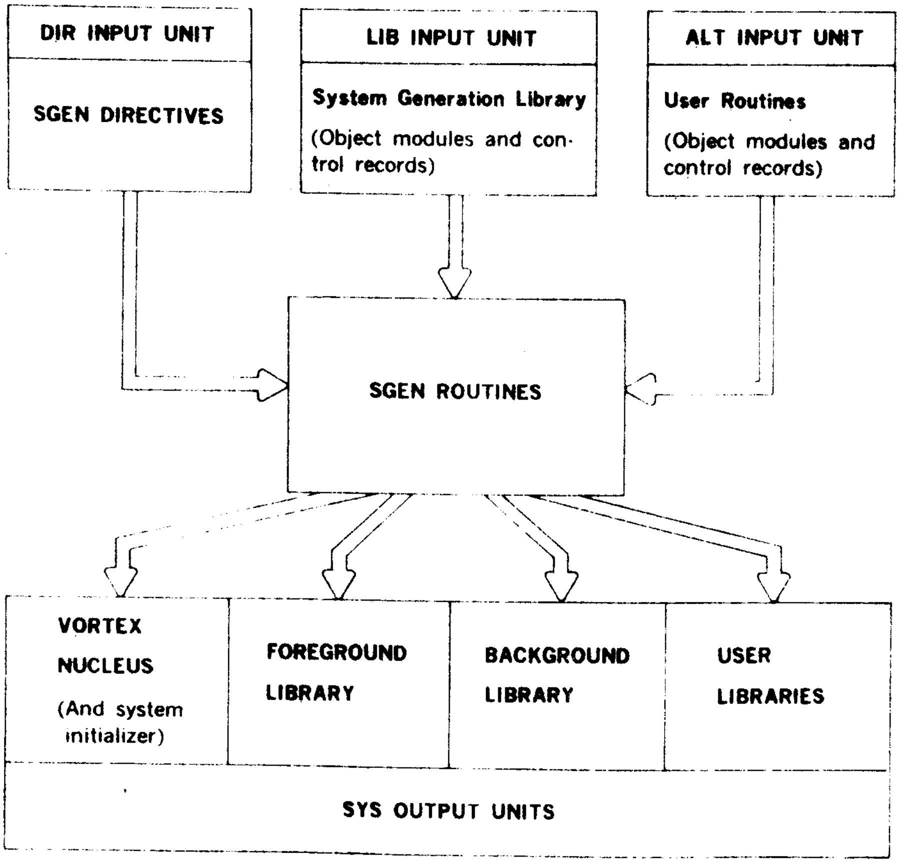
a. Input VORTEX system routines (LIB unit)

b. Input user routines (ALT unit)

c. Input SGEN directives (DIR unit)

d. Output the VORTEX system generation (SYS unit)

e. List special information and input user messages (LIS unit)



VTII-3222

Figure 15-1. SGEN Data Flow

I/O interrogation also specifies that the Teletype on hardware address 01 is the OC unit. After these peripherals are assigned, appropriate drivers and I/O controls are loaded into memory.

Note: SGEN does not build an object-module library. To construct the VORTEX object-module library (OM) or any user object-module library, use the file-maintenance component (FMAIN, section 9).

SGEN directive processing specifies the architecture of the VORTEX system based on user-supplied information that is compiled and stored for later use in building the system. SGEN directives permit the design of systems covering the entire range of VORTEX applications.

Building the VORTEX nucleus consists of gathering object modules and control records from the system-generation library (SGL, section 15.2) and from user input, and constructing the VORTEX nucleus from these data. SGL items are input through the LIB input unit, and user items through the ALT unit according to rules set up by the SGEN directives.

Building the library and the resident-task configurator consists of generating load modules from the object modules and control records input from the SGL and user data. These load modules are then cataloged and entered into the foreground, background, and user libraries. During library building, load modules can be added, deleted, or replaced as required to tailor the library to any of a wide variety of formats. After the libraries are completed, designated load modules are copied into the VORTEX nucleus to become *resident tasks*. The resident-task configuration of SGEN can also be generated without regeneration of the VORTEX nucleus or libraries (section 15.7).

SGEN directive format requires that, unless otherwise indicated (e.g., section 15.5), the directives begin in column 1 and comprise sequences of character strings having no embedded blanks. The character strings are separated by commas (,) or by equal signs (=). The directives are free-form and blanks are permitted between individual character strings, i.e., before and after commas (or equal signs). Although not required, a period (.) is a line terminator. Comments can be inserted after the period. For greater clarity in the descriptions of the directives, optional periods, optional blank separators between character strings, and the optional replacement of commas by equal signs are omitted. Section 14.4.8 describes resident tasks in greater detail.

Numerical data can be octal or decimal. Each octal number has a leading zero.

Error messages applicable to SGEN are given in Appendix A.15.

SGEN errors are divided into five categories according to type. The category of each error, as well as the specific error, is given by the error code. Recovery is automatic where manual intervention is not required. When manual intervention is necessary, the OC device expects a response after the error message is posted. The response can be either a corrected input statement (where the statement in error was an ASCII record) or the letter " C". In the latter case, the corrected input is expected on the input device where the error occurred, immediately after the " C" is input. If the input media is magnetic tape or disc pack, positioning to reread an input statement is also automatic.

15.2 SYSTEM-GENERATION LIBRARY

The **System-generation library (SGL)** is a collection of system programs (in object-module form) and control records (in alphanumeric form) from which a VORTEX system is constructed.

In the case of punched cards or of magnetic tape, the SGL occupies contiguous records, beginning with the first record of the medium.

In the case of disc pack, the SGL occupies contiguous records beginning with the second track. Track 0 contains the partition-specification table (PST, section 3.2) that specifies one partition extending from the second track (track 1) to the end of device.

The SGL and the VORTEX system cannot be on the same disc pack during system generation.

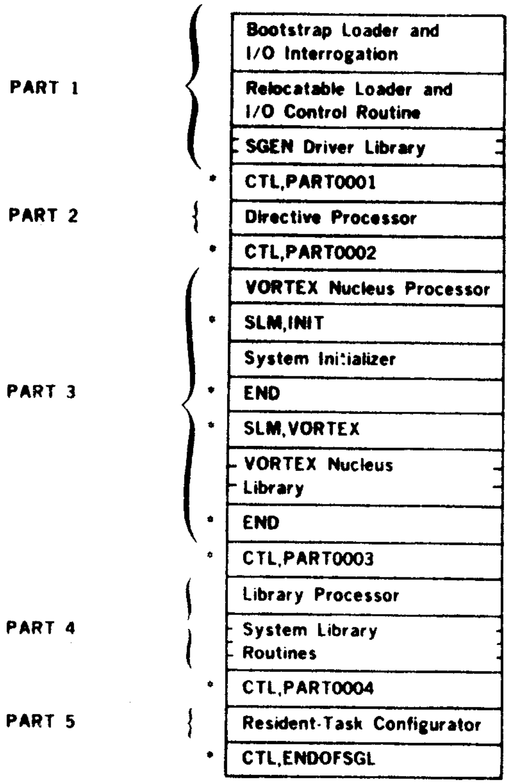
The SGL is divided into five functional parts, each separated by CTL control records (figure 15-2).

Part 1 of the SGL comprises a *VORTEX bootstrap loader* and an *I/O interrogation routine*. It also comprises the *SGEN relocatable loader*, the *basic I/O control routine*, and *library of peripheral drivers* for the use of SGEN. Part 1 consists entirely of object modules. It is loaded with device-sensitive key-in loader (section 15.3) that also serves the bootstrap loader as a read-next-record routine. The bootstrap-loader/interrogator is a core-image sequence of records generated by a VORTEX service routine. Because it calls the key-in loader to read records, the bootstrap-loader/interrogator is itself device-insensitive.

Control record CTL,PART0001 terminates part 1 of the SGL.

Part 2 of the SGL contains the *directive processor*. After being itself input, the directive processor obtains all input from the DIR and OC input devices. The system generation directives are to be placed between the directive processor and the CTL,PART0002 control record if the CIB and DIR input units are the same.

Control record CTL,PART0002 terminates part 2 of the SGL.



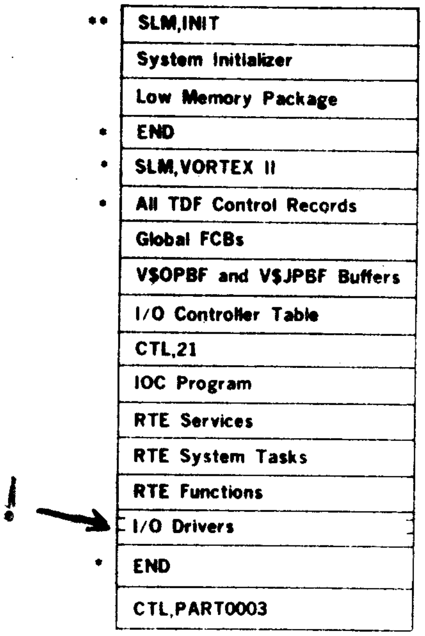
NOTE:

* = Alphanumeric control record

Figure 15-2. System-Generation Library

Part 3 of the SGL comprises all system routines and control records required to build the VORTEX nucleus (figure 15-3):

- *VORTEX nucleus processor* -- the SGEN-processing portion
- *SLM control record* indicates the beginning of the system initializer portion
- *System-initializer routines* -- object modules to be converted into the system initializer
- *END control record* -- indicates the end of the system-initializer portion
- *SLM control record* -- indicates the beginning of the VORTEX nucleus portion
- *VORTEX nucleus routines* -- control records and object modules to be converted into the VORTEX nucleus
- *END control record* indicates the end of the VORTEX nucleus portion
- *Control Record CTL,21* -- specifies the end of the nucleus table module. All user data and programs to be included in this module must precede the CTL,21 control record.
- All programs contained on the SGL between the CTL,21 and CTL,PART0003 control records are included in the nucleus program module



NOTE:

* = Alphanumeric control record

Figure 15-3. VORTEX Nucleus

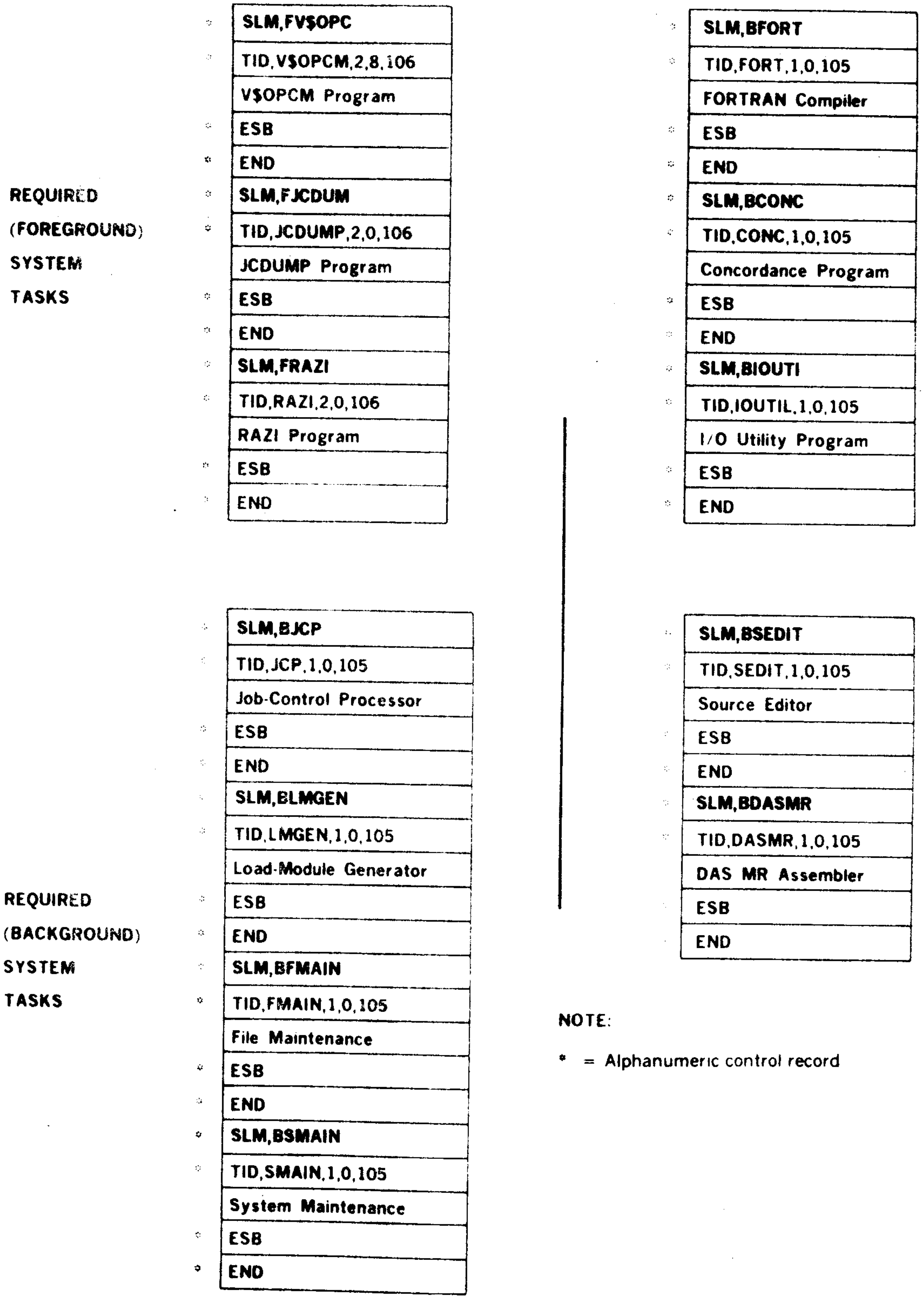
Control record CTL,PART0003 terminates part 3 of the SGL.

Part 4 of the SGL comprises all system routines and control records required to build load-module libraries on the RMD. The *library processor* converts these inputs into load modules, catalogs them, and enters them into the foreground, background, and user libraries. The library processor is followed by groups of control records and object modules, with each group forming a *load-module package (LMP)*.

Control record CTL,PART0004 terminates part 4 of the SGL.

Part 5 of the SGL contains the *resident-task configurator* portion of SGEN. The configurator copies specified load modules from the foreground library into the VORTEX nucleus, i.e., makes them resident tasks.

Control record CTL,ENDOFSGL terminates the SGL.



NOTE:

* = Alphanumeric control record

Figure 15-4. Load-Module Library

15.3 KEY-IN LOADER

SGEN is initiated on a new or initialized system by inputting the key-in loader through the CPU. The key-in loader loads the VORTEX bootstrap loader (part 1 of the SGL). Key-in loaders are available for loading from magnetic tape, punched cards, or disc pack. The required key-in loader is input to memory through the CPU console and then executed to load the VORTEX bootstrap loader.

Automatic bootstrap loader (ABL): In systems equipped with an ABL, load the key-in loader from the input medium into memory starting with address 000000. To execute the key-in loader, clear the A, B, X, I, and P registers; then press RESET, set STEP/RUN to RUN, and press START.

See hardware handbook for details on manual loading.

Table 15-1. SGEN Key-In Loaders

Address	Magnetic Tape	Card Reader	RMD 70-76x0	RMD 70-76x3
000000	010030	010054	010064	010064
000001	001010	001010	140066	140066
000002	001106	001106	001010	001010
000003	040030	040054	001106	001106
000004	001000	001000	001000	001000
000005	000012	000012	000012	000012
000006	000000	000000	000000	000000
000007	006010	006010	006010	006010
000010	000300	000300	000300	000300
000011	050027	050053	050065	050065
000012	1041zz	1002zz	1004zz	1004zz
000013	1000zz	002000	1002zz	010063
000014	001000	000046	010063	110072
000015	000021	1025zz	110072	1031zz
000016	1025zz	002000	1031zz	1002zz
000017	057027	000046	101uzz	101dzz
000020	040027	1026zz	000023	000023
000021	1011zz	004044	001000	001000
000022	000016	004444	000017	000017
000023	1012zz	057053	1025zz	1025zz
000024	100006	005001	150071	150071
000025	001000	040053	001016	001016
000026	000021	004450	000012	000012
000027	000500	002000	1000yy	1000yy
000030	177742	000046	1003zz	5000
000031		1026zz	010064	010064
000032		004044	110072	110072
000033		004450	1031zz	1031zz
000034		002000	010065	010065
000035		000046	1031xx	1031xx
000036		1022zz	120070	120070
000037		057053	005012	005012
000040		040053	1031yy	1031yy
000041		067053	1000xx	1000xx
000042		040053	1000zz	1000zz
000043		001000	1014zz	1014zz
000044		000013	000043	000043
000045		1011zz	1025zz	1025zz
000046		000000	150071	150071
000047		1016zz	001016	001016
000050		100006	000012	000012
000051		001000	060065	060065
000052		000045	040064	040064
000053		000500	010064	010064

Table 15-1. SGEN Key-In Loaders *(continued)*

Address	Magnetic Tape	Card Reader	RMD 70-76x0	RMD 70-76x3
000054		177742	140067	140067
000055			001016	001016
000056			100006	100006
000057			050064	050064
000060			040063	040063
000061			001000	001000
000062			100006	100006
000063			000001	000001
000064			000001	000001
000065			000500	000500
000065			000037	000037
000067			000060	000069
000070			000074	000074
000071			007760	007760
000072			0v0000	ww0000

where

xx = even BIC address
yy = odd BIC address
zz = device address
u = RMD unit number in Sense Instruction
u = 0 for unit 0
u = 1 for unit 1

v = RMD unit number in unit Select Instruction
v = 0 for unit 0
v = 4 for unit 1

d = RMD drive number (0-3)
ww = drive (bits 15-14) /platter (bit 13)
(i.e., platter 1 drive 0 - 02)

15.4 SGEN I/O INTERROGATION

Upon successful loading of the bootstrap loader and I/O interrogation, the OC unit outputs the message

```
IO INTERROGATION
```

after which the SGEN peripherals are specified by inputting on the OC unit the five I/O directives:

- DIR Specify SGEN directive input unit
- LIB Specify SGL input unit
- ALT Specify SGL modification input unit
- SYS Specify VORTEX system generation output unit
- LIS Specify user communication and list output unit

These directives can be input in any order. SGEN will continue to request I/O device assignments until valid ones have been made for all five functions.

SGEN drivers are loaded from the SGEN driver library according to the specifications of the SGEN I/O directives. Errors or problems with reading the drivers will cause the applicable error messages (Appendix A.15) to be output.

The general form of a SGEN I/O directive is

function = driver,device,*bic*

where

function is one of the directive names given above

driver is one of the driver names given below

device is the hardware device address

bic is the BIC address

Name*	Type of Device	Model Numbers
MTcuA	Magnetic-tape unit	70-7100
LPcuA	Line Printer	70-6701
LPcuD	All Statos models***	70-6602 70-6603
CRcuA	Card reader	70-6200
PTcuA	Paper-tape read/punch	70-6320
TYcuA	Teletype or CRT	70-6100, 70-6104
DcuA1	Rotating memory	70-7702
DcuA2	Rotating memory	70-7703
DcuA5	Rotating memory	620-49
DcuB	Rotating memory	70-7600, 70-7610

Name*	Type of Device	Model Numbers
DcuC	Rotating memory**	70-7500
DcuD	Rotating memory**	70-7510
DcuF****	Rotating memory**	70-7603

* where c stands for the controller number (0, 1, 2, or 3), and u for the unit number (0, 1, 2, or 3).

**Always specify the first master unit of a particular device as being on controller 0, the second master unit on controller 1, etc. Regardless of the controller specifications in the EQP directives, different controller numbers must be used for each RMD type. (i.e., if using MT 1 on DA 12, specify MT00A). If the system has a 7600 and 7500 RMD, then specify D00B and D10C.

*** Statos 33 is not supported during system generation.

**** Unit number = 0 through 7.

15.4.1 DIR (Directive-Input Unit) Directive

This directive specifies the unit from which all SGEN directives (section 15.5) will be input (DIR unit). The directive has the general form

DIR = driver,device,*bic*

where

driver is one of the driver names MTcum, TYcum, PTcum, or CRcum (m is a model code, as given in 15.4)

device is the hardware device address

bic is the BIC address (used only, and then optionally, for magnetic-tape units)

Example: Specify Teletype unit 0 having model code A and hardware device address 01 as the DIR unit.

```
DIR=TY00A,01
```

15.4.2 LIB (Library-Input Unit) Directives

This directive specifies the unit from which the SGL will be input (LIB unit). The directive has the general form

LIB = driver,device,*bic*

where

driver is one of the driver names MTcum, CRcum, or Dcum

device is the hardware device address

bic is the BIC address (used only, and then optionally, for magnetic-tape units) mandatory for RMDs

Example: Specify magnetic-tape unit 0 having model code A and hardware device address 010 (no BIC) as the LIB unit.

```
LIB=MT00A,010
```

15.4.3 ALT (Library-Modification Input Unit) Directive

This directive specifies the unit from which object modules that modify the SGL will be input (ALT unit). The directive has the general form

ALT = driver,device,*bic*

where

driver is one of the driver names MTcum, PTcum or CRcum

device is the hardware device address

bic is the BIC address (used only, and then optionally, for magnetic-tape units)

Example: Specify card reader unit 0 having model code A and hardware device address 030 as the ALT unit.

```
ALT=CR00A,030
```

15.4.4 SYS (System-Generation Output Unit) Directive

This directive specifies the RMD(s) onto which the VORTEX system will be generated, with the VORTEX nucleus on the first such device specified. Up to 16 RMDs can be specified. The directive has the general form

SYS = **driver1,device1,bic1;***driver2,device2,*
bic2; ..*;drivern,devicen,bicn*

where

driver is an RMD driver name such as Dcum, where c = controller, u = unit, and m = model code

device is the hardware device address of the corresponding **driver**

bic is the **mandatory** address of the applicable BIC or BTC

All RMDs specified in the EQP directives (15.5.2) must be specified in the SYS directive. Subsequent SYS directives will overlay the previous directives. If all RMDs cannot be specified in a single line, then the directive must be terminated with a colon. This will cause the next input line to be treated as a continuation of the previous SYS directive. The additional input lines begin with the driver parameter. The directive "SYS=" must not be used on additional SYS directive input lines.

Examples: Specify RMD 0 having model code B, hardware device address 016, and BIC address 020 as the SYS unit.

```
SYS=D00B,016,020
```

Specify two SYS units: RMD 0 with model code A2, hardware device address 014, and BIC address 020; and RMD 0 with model code B, hardware device address 015, and BIC address 022.

A system with 70-7500 (620-34)or 70-7510 (620-35) disc requires a special formatting program, described in section 18.4. This program formats disc packs and performs bad-track analysis.

```
SYS=D00A2,014,020;D10B,015,022
```

15.4.5 LIS Directive

This LIS (User-Communication and List Output Unit) directive specifies the unit that will be used for user communication and list output (LIS unit). The directive has the general form

LIS = driver,device

where

driver is one of the driver names TYcum or LPcum

device is the hardware device address

The following information appears on the LIS unit:

a. Error messages

b. Load map of each load module

c. Directives input through the DIR unit (section 15.4.1)

d. Partition table for each system RMD

To suppress listing during system generation set "map" to zero in EDR directive.

Example: Specify line printer 0 having model code A and hardware device address 035 as the LIS unit.

```
LIS=LP00A,035
```

15.5 SGEN Directive Processing

Upon successful loading of the SGEN directive processor, the OC and LIS (section 15.4.5) units output the message

```
INPUT DIRECTIVES
```

to indicate that SGEN is ready to accept SGEN directives from the DIR unit (section 15.4.1).

The SGEN directives described in this section can be input in any order, except for the EDR directive (section 15.5.14), which is input last to terminate SGEN directive input.

In cases of conflicting data, SGEN treats the last information input as the correct data.

Errors cause the output of the applicable error messages (Appendix A.15).

The general form of an SGEN directive is

aaa,p(1)*xp(2)x...xp(n)*

where

aaa is a three-character SGEN directive name

each **p(n)** is a parameter as indicated in the specifications for the individual directives

each *x* is a punctuation mark as indicated in the specifications for the individual directives

In contrast to most VORTEX system directives, **the punctuation in SGEN directives is exactly as defined in the specifications for the individual directives, although** blanks are allowed between parameters, i.e., before or after punctuation marks. SGEN directives begin in column 1 and can contain up to 80 characters.

SGEN directives are listed on the OC and LIS units.

15.5.1 MRY (Memory) Directive

This directive specifies the memory-related parameters of SGEN. It has the general form

MRY,memory,common,size[,V75]

where

memory is the extent of the memory area available to VORTEX (minimum 12K = 027777)

common is the extent (0 or positive value) of the foreground blank-common area

size is the total physical memory available to

V75 specifies V75 system

Examples: Specify a 48K memory for VORTEX with a foreground blank common area of 0200 words. Save locations 075777 to 077777 of the first 32K memory for AID I.

```
MRY,075777,0200,48
```

Specify an 18,000-word memory for a VORTEX V75 system with no foreground blank-common area.

```
MRY, 18000,0,V75
```

15.5.2 EQP (Equipment) Directive

This directive defines the peripheral architecture of the system It has the general form

EQP,name,address,number,bic,retry,*alg,mul*

where

name is the mnemonic for a peripheral controller

address is the controller device address (01 through 077 inclusive)

number is the number (1 through 4, inclusive) of peripheral units attached to the controller

bic is the BIC or BTC address (0 if no BIC applies)

retry is the number (0 to 99, inclusive) of retries to be attempted by the I/O driver when an error is encountered

alg is the I/O algorithm value (0≤ alg ≤ 1) as a decimal fraction (see section 14.4.3. word 7 for the calculation of this value). NOTE: this is an optional parameter and is not needed unless a change is desired in the algorithm value. If this parameter is to be used on non-process I/O controller tables, the subject controller table must contain CTIOA as an entry name

mul is the multiplexor address (this parameter applies only to process I/O drivers)

Acceptable mnemonics for name are:

•	MTnm	Magnetic-tape unit
•	LPnm	Line printer
•	CRnm	Card reader
•	PTnm	Paper tape reader/punch
•	TYnm	Teletype
•	CTnm	CRT device
•	CPnm	Card Punch
•	Dnm	RMD
•	CI	Process input
•	CO	Process output
•	WCS	Writable control store
•	SPnm	Spool Unit
•	MXnm	Communication Multiplexor
•	TCnm	Psuedo TCM

Where n is the controller number (0, 1, 2, or 3), and m is the model code (table 15-2).

Controller tables are arranged according to the priority levels of their task-identification blocks (TIDBs). On any given level, the tables are arranged in the input sequence of the corresponding EQP directives. Device-specification table (DST) entries are unsorted.

The following order is suggested for peripheral controllers.

a. RMDs

b. Operator-communication (OC) device (section 17)

c. Magnetic-tape units

d. Other units

For the 70-7603/7013 disc, a special DEF directive must be included for each EQP directive used for this model disc

DEF,V$DSKx,y

where

x is the controller number (0-3)

y is a bit pattern in bits 0-7. Bit(n) corresponds to platter(n). The bit is set if the corresponding platter is part of a dual platter driver.

Example: A system contains two 70-76x3 controllers with the following drives attached:

Controller 0 has 1 dual unit and 3 single units
Controller 1 has 2 dual units, and 1 single
unit, and 1 dual unit

the corresponding directives would be:

```
EQP,D0F,016,5,020,5
DEF,V$DSK0,3
EQP,D1F,017,7,022,5
DEF,V$DSK1,0157
```

Table 15-2. Model Codes for VORTEX Peripherals

Code	Model Number	Description
TYnA	70-6104	ASR Teletype Model 33
	(620-08)	ASR Teletype Model 35
CTnA	70-6401	CRT keyboard/display
CRnA	70-6200	Card reader: 300 or 600 cards/minute
	(620-22,	
	620-25)	
CPnA	70-6201	Card punch: 35 cards/minute
	(620-27)	
MTnA	70-7100	Magnetic-tape: 9-track, 800 bpi, 25 ips
	(620-30)	
	(620-31A)	Magnetic-tape: 7-track, 200-556 bpi
	(620-31B)	Magnetic-tape: 7-track, 200-800 bpi
	(620-31C)	Magnetic-tape: 7-track, 556-800 bpi
	70-7102	Magnetic tape: 9-track, 800 bpi, 37 ips
	(620-32)	
	70-7103	Slave unit with 620-32
	(620-32A)	
MXnA	70-520X (520X)	Data communications multiplexor
	70-521X	
DnA	620-47,-48,-49	Rotating memory
	70-770X	Rotating memory
	(620-43C,-43D)	
DnB	70-7600	Rotating memory
	(620-36)	
	70-7610	Rotating memory
	(620-37)	
DnC	70-7500	Rotating memory
	(620 35)	
DnD	70-7510	Rotating memory
	(620-34)	
DnF	70-7603	Rotating Memory
	70-7613	
PTnA	70-6320	Paper-tape reader/punch
	(620-55A)	
	(620-51A)	
LPnA	70-6701	Line Printer
	(620-77)	
LPnD	70-6602	Statos-31 Printer/plotter

Table 15-2. Model Codes for VORTEX Peripherals
(continued)

Code	Model Number	Description
LPnE	70-6603 (620-76)	Statos-31,-41 Printer/plotter
LPnG	70-6603 (42,51,71)	Statos-31/42 Printer/plotter
LPnH	70-7702	Statos-31 (-41,-51,-52)
LPnJ	70-66xx	Statos-33
CInA	See sec. 19	Process I/O
COnA	See sec. 19	Process I/O
WCS	70-4002	Writable control store

Note: Other peripheral devices can be added to the system by creating an EQP directive with a unique phsyical-unit name for the device. A controller table with the same name is then added to the VORTEX nucleus by an ADD directive (section 15.5.5).

Example: Define a system containing one model B RMD, one model A magnetic-tape unit, one mode A card reader, one model A line printer, one model A Teletype, one model A high-speed paper-tape reader/punch, one model A card punch, and a writable control store.

```
EQP,D0B,016,1,020,3
EQP,MT0A,010,1,022,5
EQP,CR0A,030,1,024,0
EQP,LP0A,035,1,024,0
EQP,TY0A,01,1,0,0
EQP,PT0A,037,1,0,0
EQP,CP0A,031,1,022,0
EQP,WCS,074,1,0,0
```

The paper width of each Statos on the system must be defined through use of the SGEN DEF directive (see section 15.5.14). This directive has the form

DEF,V$SWnm,c

where

n	is the controller number (0, 1 or 2)
m	is the Statos model code (D,E,G,H, or J)
c	is the width code, defined as

0 = 8-1/2-inch	4 = with SLIB
1 = 11-inch	5 = with SLIB
2 = 14-7/8-inch	6 = with SLIB
3 = 22-inch	7 = with SLIB

Example: Specify a SGEN directive for model G Statos on controller 1 with 14-7/8-inch width paper

```
DEF,V$SW1G,2
```

15.5.3 PRT (Partition) Directive

This directive specifies the size of each partition on each RMD. It has the general form

PRT,Dcup(1),s(1),k(1);*Dcup(2),s(2),k(2);...;*
Dcup(n),s(n),k(n)

where

Dcup(n)	is the name of the RMD partition with **c** being the number (0, 1, 2, or 3) of the controller, **u** the unit number (0, 1, 2, or 3), and **p** the partition letter (A through T, inclusive)
s(n)	is the number (octal or decimal) of tracks in the partition. The maximum partition size on any RMD is 32,768 sectors
k(n)	is the protection code (single alphanumeric character including **$**) for the partition, or * if the partition is unprotected

At least six paritions are required for the system rotating memory. PRT directives are required for every partition on every RMD in the system. While the partition specifications can appear in any order, the set of partitions specified for each RMD must comprise a contiguous group, e.g., the sequence D00A, D00C, D00D, D00B is valid, but the sequence D00A, D00C, D00D, D00E constitutes an error.

NOTE: If the LIB unit is an RMD, the PRT directives for that RMD are ignored and the existing PST for the RMD is used. However, even though the PRT directives are ignored the RMD unit should have at least one PRT directive. RAZI may be used to partition the RMD unit after system generation. If the RMD SGL is to be saved, it must be replaced with a scratch pack prior to executing RAZI for that unit.

Logical units 101 through 106 inclusive have preassigned protection codes. Do not attempt to change these codes.

Preassigned Protection Codes

Unit Number	101	102	103	104	105	106
Code	S	B	C	D	E	F

Total number of tracks of all partitions and the capacity of VORTEX nucleus must not exceed rotating-memory track capacity. The nucleus size is equal to the memory size divided by the product of the number of sectors per track and 120. Tracks not included by a PRT directive are not accessable to the system.

Example: Specify the following partitions on two RMDs.

RMD No.	Partition	Tracks	Protection Code
0	A	2	C
0	B	20	F
0	C	25	E
0	D	40	D
0	E	8	S
0	F	18	B
0	G	18	None
0	H	66	None
1	A	40	None
1	B	60	R
1	C	50	None
1	D	52	X

```
PRT,D00A,2,C;D00B,20,F
PRT,D00C,25,E;D00D,40,D;D00E,8,S
PRT,D00F,18B;D00G,18,*;D00H,66,*
PRT,D01D,52,X;D01C,50,*
PRT,D01A,40,*;D01B,60,R
```

15.5.4 ASN (Assign) Directive

This directive assigns logical units to physical devices. It has the general form

ASN,lun(1) = dev(1),*lun(2) = dev(2),...,lun(n) = dev(n)* where each

lun(n) is a logical unit number (1 through 100 or 107 through 255, inclusive) that can be followed optionally by a two-character logical unit name e.g., 107:Y7

dev(n) is a four-character physical-device name, e.g., TY00,D00G (table 17-1)

If a new assignment specifies the same logical unit as a previous assignment, the old one is replaced and is no longer valid. All logical units for which physical device assignments are not explicitly made are considered *dummy units*, except preassigned.

Restrictions: Any attempt to change one of the preset logical unit name:number or name:number:partition relationships given in table 15-3 will cause an error to be flagged. Table 15-4 indicates the permissible physical unit assignments for the first 12 logical units (with PO automatically set equal to SS for normal assembler operation).

Example: Specify physical device assignments for logical units 1-12, inclusive, 107 and 108, and 180 and 181, where the last two units have, in addition to their numbers, two-character names.

```
ASN,1=TY00,2=CR00,3=TY01,4=CR00
ASN,5=LP00,6=MT00,7=D00I,8=D00G
ASN,9=D00H,10=D00G,11=TY00,12=LP00
ASN,107=LP00,108=CR00
ASN,180:S6=MT00,181:S8=MT01
```

Table 15-3. Preset Logical-Unit Assignments

Preset logical-unit name/number relationships:

OC = 1	LO = 5	GO = 9	13 = RPG IV READ
SI = 2	BI = 6	PO = 10	14 = RPG IV PUNCH
SO = 3	BO = 7	DI = 11	15 = RPG IV PRINT
PI = 4	SS = 8	DO = 12	

[illegible] p. 3-52 in I/O [illegible] chapt [illegible]

Preset logical-unit/RMD-partition relationships:

Logical-Unit Name	Logical-Unit Number	Partition Name	Protection Key	Minimum VORTEX Sector Allocation	
CL	103	D00A	C	025 (see note 5)	96
FL	106	D00B	F	0106	672
BL	105	D00C	E	01135	1652
OM	104	D00D	D	0417	
CU	101	D00E	S	0310 (See note 1)	336
SW	102	D00F	B	0310 (See note 2)	Assuming 24K

Optional logical-unit/RMD-partition relationships

GO	9	D00G	none	0310 (See note 3)	528
SS	8	D00H	none	varies	
PO	10	D00H	none	0515 (See note 4)	
BI	6	D00I	none	varies	
BO	7	D00I	none	varies	

1. CU file must be as large as background task's largest part in central memory at one time (24K assumed above).

2. SW file must be as large as the largest single task including overlays (24K assumed above).

3. GO file must be somewhat larger than the largest task run in load-and-go mode (24K assumed). If system is foreground only or all tasks will be entered in libraries before execution, this partition may be eliminated.

4. PO file must be large enough for source images of the largest task to be assembled or compiled. Source images are stored 3 card images per sector (1000 cards assumed above). If this function is assigned to magnetic tape, this partition may be eliminated.

5. There are 12 entries per 2 sectors. Number of sectors equals numbers of entry ÷ 6.

Table 15-4. Permissible Logical-Unit Assignments

		Permissible Physical Units				
Logical Units		Teletype or CRT	RMD or MT	Line Printer	Other Output (CP,PT)	Other Input (PT,CR)
1	(OC)	X				
2	(SI)	X	X			X
3	(SO)	X				
4	(PI)	X	X			X
5	(LO)	X	X	X	X	
6	(BI)		→ X			X
7	(BO)		→ X		X	
8	(SS)		X			
9	(GO)		X			
10	(PO)		X			
11	(DI)	X				X
12	(DO)	X		X		

15.5.5 ADD (SGL Addition) Directive

This directive specifies the SGL control records and object modules *after which* new control records and/or object modules are to be added during nucleus generation. It has the general form

ADD,p(1),*p(2),...,p(n)*

where each **p(n)** is the name of a control record or an object module *after which* new items are to be added.

When the name of a specified item is read from the SGL, the program is processed and the message

```
ADD AFTER p(n)
READY
```

appears on the OC unit. User response on the OC unit is either

```
ALT*
```

if an item is to be added from the SGEN ALT input unit (section 15.4.3), or

```
LIB
```

if processing from the SGL is to continue. If the former response is used, SGEN reads an object module from the ALT unit and adds it to the SGL, then prints on the OC unit the message

```
READY
```

to which the user again responds with either ALT or LIB on the OC unit.

Example: Specify that items are to be added during nucleus generation after control records or object modules named PROG1, PROG2, and PROG3.

```
ADD,PROG1,PROG2,PROG3
```

15.5.6 REP (SGL Replacement) Directive

This directive specifies the SGL control records and object modules to be replaced with new control records and/or object modules during nucleus generation. It has the general form

REP,p(1),*p(2),...,p(n)*

where each **p(n)** is the name of a control record or an object module to be replaced.

When the name of the specified item is read from the SGL, the item is skipped and the message

```
REPLACE p(n)
READY
```

appears on the OC unit. User response on the OC unit is either

```
ALT*
```

if an item is to be replaced by one on the SGEN ALT input unit (section 15.4.3), or

```
LIB
```

if processing from the SGL is to continue. If the former response is used, SGEN reads an object module from the ALT unit and replaces p(n) with it in the SGL, then prints on the OC unit the message

```
READY
```

to which the user again responds with either ALT or LIB on the OC unit.

Example: Specify that control records or object modules named PROGA and PROGB are to be replaced during nucleus generation.

```
REP,PROGA,PROGB
```

*ALT has a special form which allows searching the ALT device for a specified program. The form is

```
ALT,name
```

where

name is one to six alphanumeric characters representing the TITLE name of the model to be added

name can either specify an object module name or a TDF record name. When specified, ALT will search the alternate unit from its current position for the specified module. If an EOF is encountered prior to finding the module an SG08 diagnostic occurs. To cause the alternate unit to rewind prior to each search, set Sense Switch 1 prior to entering the ALT directive. If no module name is specified, ALT will load from its current position.

For example, to search for and load an object module named PGRM1, specify

```
ALT,PGRM1
```

To search for and load a TDF directive for TBLPOF, specify ALT,TBLPOF

15.5.7 DEL (SGL Deletion) Directive

This directive specifies the SGL control records and object modules that are to be deleted during nucleus generation.It has the general form

DEL,p(1),*p(2),. .,p(n)*

where each **p(n)** is the name of a control record or an object module to be deleted.

When the name of a specified item is read from the SGL, the item is skipped and processing continues with the following control record or object module.

Example: Delete, during nucleus generation, all control records and object modules named PROG1 and PROG2.

```
DEL,PROG1,PROG2
```

15.5.8 LAD (Library Addition) Directive

This directive specifies the SGL load-module package *after which* new load-module packages are to be added during library generation. It has the general form

LAD,p(1),*p(2),...,p(n)*

where each **p(n)** is the name of a load-module package from an SLM control directive *after which* new items are to be added.

When the name of a specified load-module package is read from the SGL, the program is processed and the message

```
ADD AFTER p(n)
READY
```

appears on the OC unit. User response on the OC unit is either

```
ALT
```

if a load-module package is to be added from the SGEN ALT input unit (section 15.4.3), or

```
LIB
```

if processing from the SGL is to continue. If the former response is used, SGEN reads a module from the ALT unit and adds it to the library, then prints on the OC unit the message

```
READY
```

to which the user again responds with either ALT or LIB on the OC unit.

Example: Specify that items are to be added, during library generation, after load-module packages named PROG1, PROG2, and PROG3.

```
LAD,PROG1,PROG2,PROG3
```

15.5.9 LRE (Library Replacement) Directive

This directive specifies the SGL load-module package to be replaced with new load-module packages during library generation. It has the general form

LRE,p(1),*p(2),...,p(n)*

where each p(n) is the name of a load-module package from an SLM control directive to be replaced.

When the name of the specified load-module package is read from the SGL, the program is skipped and the message

```
REPLACE p(n)
READY
```

appears on the OC unit. User response on the OC unit is either

```
ALT
```

if module is to be replaced by one on the SGEN ALT input unit (section 15.4.3), or

```
LIB
```

if processing from the SGL is to continue. If the former response is used, SGEN reads a module from the ALT unit and replaces p(n) with it in the SGL, then prints on the OC unit the message

```
READY
```

to which the user again responds with either ALT or LIB on the OC unit.

Example: Specify that load-module packages named PROGA or PROGB are to be replaced during library generation.

```
LRE,PROGA,PROGB
```

15.5.10 LDE (Library Deletion) Directive

This directive specifies the SGL load-module packages that are to be deleted during library generation. It has the general form

LDE,p(1),*p(2),...,p(n)*

where each p(n) is the name of a load-module package from an SLM control directive to be deleted.

When the name of a specified load-module package is read from the SGL, the load-module package is skipped and processing continues with the following load module.

Example: Delete, during library generation, all load-module packages named PROG1 and PROG2.

```
LDE,PROG1,PROG2
```

15.5.11 PIM (Priority Interrupt) Directive

This directive defines the interrupt-system architecture by specifying the number of priority interrupt modules (PIMs) in the system, the interrupt levels to be enabled at system-initialization time, and the interrupts to be manipulated by user-coded interrupt handlers. The PIM directive has the general form

PIM,p(1),q(1),r(1),s(1);*p(2),q(2),r(2),*
s(2);...;p(n),q(n),r(n),s(n)

where each

p(n) is an interrupt line number comprising two *octal* digits with the first being the PIM number and the second the line number within the PIM. The two digits must be preceded by a zero, e.g., 002,011

q(n) is the name (1 to 6 characters) of the task handling the interrupt The name format is TBxxxx, where xxxx is the hardware code name. For s(n) = 2, q(n) is the interrupt processor entry name.

r(n) is the content of the interrupt event word in octal notation (see appendix F for nonzero values for standard hardware)

s(n) is 0 for an interrupt using the common interrupt-handler or 1 for a directly connected interrupt option 1, or 2 for directly connected interrupt option 2. (Described in section 14.4.5)

If an interrupt line is to use the common interrupt handler, a TIDB is generated for the related interrupt-processing routine, which can be in the VORTEX nucleus or in the foreground library.

If an interrupt line is to have a direct connection, the interrupt-processing routine must be added to the VORTEX nucleus. Failure to do so results in an error message.

Example: Specify two interrupt lines, one handled by the common interrupt handler, the other directly connected, option 1.

```
PIM,002,TBMT0A,00001,0;003,TBLP0B,01,1
```

Note: The only interrupt used by the magnetic-tape I/O driver is the motion complete.

Note: The interrupt event word, r(n) for a Teletype or CRT (Teletype compatible) must be set to 01 for input interrupt on 02 for output interrupt.

15.5.12 CLK (Clock) Directive

This directive specifies the values of all parameters related to the operation of the real-time clock. It has the general form

CLK,clock,counter,interrupt

where

clock is the number of microseconds in the basic clock interval

counter is the number of microseconds in the free-running counter increment period. Stored in V$FREE but not used in VORTEX II. Its nominal value is 100.

interrupt is the number of milliseconds in the user interrupt interval: This value must be between 5 and 50.

The value of **interrupt**, when not a multiple of 5 milliseconds, is increased to the next multiple of 5 milliseconds; e.g., if **interrupt** is 31, the interrupt interval is 35 milliseconds.

Example: Specify a basic clock interval of 100 microseconds, a free-running counter rate of 100 microseconds, and a user interrupt interval of 20 milliseconds.

```
CLK,100,100,20
```

15.5.13 TSK (Foreground Task) Directive

This directive specifies the tasks in the foreground library that are to be made resident tasks. It has the general form

TSK,task(1),*task(2),...,task(n)*

where each **task(n)** is the name of an RMD foreground-library task that is to be made a resident task.

If this directive is input as part of a full system generation, the names are those of tasks that will be built on the foreground library during the library-building phase (section 15.7).

Resident TIDBs are not created for the tasks defined on the TSK directives to be resident tasks. A TIDB is created each time a resident task is specified on a SCHED call. A resident TIDB is created at system generation for each task specified on a TDF directive (paragraph 15.6.2).

These tasks are treated as user mode tasks and are not executed in map 0. Hence, I/O instructions cannot be executed by these tasks. Resident map 0 tasks are added to the nucleus by adding the programs on the SGL between the CTL,21 and CTL,PART003 control records. Section 14.4.8 describes resident tasks.

Example: Specify that foreground-library tasks RTA, RTB, and RTC be made resident tasks.

```
TSK,RTA,RTB,RTC
```

15.5.14 DEF (Define External) Directive

This directive enters a name with a corresponding absolute value into the SGEN loader tables and the CL library. It has the general form

DEF,name(1),value(1);*name(2),value(2);...;name(n)*
value(n)

Modules processed by either SGEN or LMGEN can reference any names defined by the DEF directive

Example: Use the DEF directive for the VTAM LCB address in CTMX0A. The entry in CTMX0A for the LCB address might be

```
EXT      V$LCWO
DATA     V$LCWO
```

Then, the following DEF directive would define the LCB to be at location 075000

```
DEF,V$LCWO,075000
```

15.5.15 EDR (End Redefinition) Directive

This directive, **which must be the last SGEN directive**, specifies all special system-parameters, or terminates SGEN directive input. If only a redefinition of resident tasks is required, the EDR directive is of the form

EDR,R

but if a full SGEN is necessary, the EDR directive has the general form

EDR,S,tidb,stack,part,list,kpun,map,*analysis*

where

tidb is the number (01 through 0777, inclusive) of 25-word empty TIDBS allocated

stack is the size (0 through 037777, inclusive) of the storage and reentry stack allocation, which is equal to the number of words per reentrant subroutine multiplied by the number of levels calling the subroutine summed overall subroutines

part is the maximum number (6 through 20, inclusive) of partitions on an RMD in the system

list * is the number of lines per page for the list output, with typical values of 44 for the line printer and 61 for the Teletype

kpun is 26 for 026 keypunch Hollerith code, or 29 for 029 code

map is L if map information is to be listed, or 0 if it is to be suppressed

analysis is 0 or blank if a complete bad track analysis is desired on all RMD's, or 1 if the bad track tables from the last SGEN are to be reused. If this parameter is omitted, a full analysis is performed. A value of 1 may be entered only when an analysis has been made on a previous SGEN effort. If SGL is on slave disc, bypass (SET 1) the bad track analysis.

Bad-track or RMD partitioning analysis is performed following input of the EDR directive. When that process is complete, the VORTEX nucleus or resident-task processor is loaded into main memory.

Examples: Specify redefinition of resident tasks only.

```
EDR,R
```

Specify full system generation with no stack area, a maximum of five partitions per RMD, 44 lines per page on the list output, 026 keypunch mode, and a list map, and a new bad track analysis is wanted.

```
EDR,S,0,0,5,44,26,L
```

Specify full system generation with 0500 addresses in the stack area, a maximum of 20 partitions per RMD, 30 lines per page on the list output, 029 keypunch mode, and suppression of the list map. Assume bad track tables from the last SGEN are still good, and reuse them.

```
EDR,S,0,0500,20,30,29,0,1
```

15.5.16 Required Directives

VORTEX system including writable control store (WCS) must include an EQP,WCS...directive.

Systems without a WCS must delete certain WCS support software modules. In particular, the following directives should be included to delete the MIUTIL and WCSRLD tasks:

```
LDE,FMIUTI
LDE,FWCSRL
```

In addition, the following directives may optionally be used to delete the remaining microprogramming support modules. These modules may be used on systems without WCS, but their deletion will make extra space available in the background library. The following directives delete the microprogram assembler and the simulator:

```
LDE,BMIDAS
LDE,BMICSI
```

Systems including VTAM require a DEF directive to define the LcB address. The format is:

DEF, V$LcWn, aaaaaa where n is the DCM number and aaaaaa is the LcB address for the DCM

Systems including a statos printer/plotter require a DEF directive to define the bed width. The format is:

```
DEF, V$SWcm,a
where c = controller number
      m = model code
      a = 0 for 8-1/2 inches        4 = with SLIB
          1 for 11 inches           5 = with SLIB
          2 for 14-5/8 inches       6 = with SLIB
          3 for 22 inches           7 = with SLIB
```

15.6 BUILDING THE VORTEX NUCLEUS

If a full system generation has been requested by the S form of an EDR directive (section 15.5.15), the nucleus processor is loaded upon completion of directive processing. Once loaded, the nucleus processor reads the SGL routines and builds the VORTEX nucleus as specified by the routines and the SGEN control records.

There are three SGEN control records used in building the nucleus:

•	SLM	Start load module
•	TDF	Build task-identification block
•	MEM	Default extra memory pages
•	END	End of nucleus library

Normally these control records are used only to replace existing SGL control records.

VORTEX nucleus processing consists of the automatic reading of control records and object modules from the SGL, and, according to the specifications made by SGEN directives, either ignoring the item or incorporating it into the VORTEX nucleus. The only manual operations are the addition and replacement of object modules during system generation. In these cases, follow the procedures given in section 15.5.5 and 15.5.6, respectively.

15.6.1 SLM (Start Load Module) Directive

This directive specifies the beginning of a load module. Its presence indicates the beginning of the system initializer or VORTEX nucleus. The directive has the general form

SLM,name

where name is the name of the load module that follows the directive

Example: Indicate the beginning of the VORTEX nucleus.

```
SLM,VORTEX
```

15.6.2 TDF (Build Task-Identification Block) Directive

This directive specifies all parameters necessary to build a task identification block in the VORTEX nucleus. It has the general form

TDF,name,exec,ctrl,stat,level ,V75

where

name is the name (1 to 6 alphanumeric characters) given to the TIDB for linking purposes

exec is the name (1 to 6 alphanumeric characters) associated with the execution address of the task

ctrl is the name (1 to 6 alphanumeric characters) of the controller table required for Teletype and CRT processing tasks, or is 0 for any other task

stat is the 16-bit TIDB status word where the settings of the individual bits have the significance shown in table 15-5

levl is the priority level of the related tasks

V75 specifies long TIDB for V75 system

Example: Define a foreground resident task PROG1 on priority level 10 to execute on boot.

The TDF directive causes a resident TIDB to be created for the specified task. The task itself may or may not be a resident task, as defined by the status word (stat). See section 15.5.13 for generation of resident tasks without resident TIDB.

Table 15-5. TIDB Status-Word Bits

Bit	When Set Indicates	Explanation
15	Interrupt suspended	The task is suspended during the processing of a higher-priority task. The contents of volatile registers are stored in TIDB words 12-16 (interrupt stack).
14	Task suspended	The task is suspended because of I/O or because it is waiting to be activated by an interrupt, time delay, or another task. The task is activated whenever this bit is zero, or if TIDB word 3 has an interrupt pending and the task expects the interrupt.
13	Task aborted	The task is not activated. All stacked I/O is aborted, but currently active I/O is completed.

Table 15-5. TIDB Status-Word Bits (continued)

Bit	When Set Indicates	Explanation
12	Task exited	The task is not activated. All stacked and currently active I/O is completed.
11	TIDB resident	The TIDB (drivers, task-interrupt processors, resident tasks, and time-scheduled tasks) is resident and not released when the task is aborted or exited.
10	Task resident	The task is resident and not released when aborted or exited.
9	Foreground task	The task is in protected foreground.
8	Check-point flag	Set: may be check-pointed by a lower priority task. Reset: may not be check-pointed by a lower priority task.
7	Task scheduled by time increment	The task becomes nonsuspended when a specified time interval is reached.
6	Time delay active	The clock decrements the time counter that, upon reaching zero, clears bit 14.
5	Task checkpointed	The background task is checkpointed and suspended. I/O is not activated.
4	Error in task	The task contains an error that will cause an error message to be output.
3	Task interrupt expected	A task interrupt is expected.
2	Overlay task	The task contains overlays.
1	Task-schedule this task	The scheduling task is suspended until the scheduled task exits or aborts.
0	Task searched, allocated and loaded	The task is loaded in memory and is ready for execution.

15.6.3 END Directive

This directive indicates the end of the system initializer or the VORTEX nucleus. It has the form

END

Example: Indicate the end of the system initializer.

```
END
```

15.6.4 MEM Directive

This optional directive performs the same function as the same directive in LMGEN (see section 6.2.7). The directive has the general form

MEM,n

where

n is the number of extra pages desired.

This directive, if used, must appear after the last ESB directive and before the END directive.

15.6.5 Memory Parity Considerations

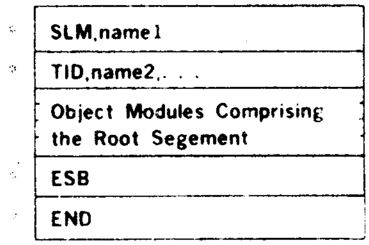
Memory parity is not a supported feature under VORTEX. For those systems which require the use of memory parity, the user may write his own memory-parity service routine (see section 14) and add it to the system. The following are considerations when using memory parity:

- The memory parity interrupt trap must be an even modulo-8 address, e.g., 010, 0100, 0110, 0200, etc. The exact address depends upon the number of PIMs in the system. For example, a system with 3 PIMs can use any of the following addresses: 0160, 0170, 0200, 0230, 0240, 0250, 0260, 0270, or 010. If 4 PIMs are in the system, then any of the above addresses except for 0160 and 0170 may be used. In the case where all 8 PIMs are used, the only available address will be 010.
- For trap addresses between 0100 and 0277, the SGEN PIM directive, specifying the direct connect option, may be used to link up the trap address with the user's memory-parity routine. If a trap address of 010 is used, the PIM directive cannot be used. In this case, the easiest means of linking the trap address and the service routine would be to modify the "low-core" module (V$LMEMBK) to specify an EXT to the user's interrupt service routine.
- No enable/disable memory parity instructions are required and hence no changes are required for the system initializer.

15.7 BUILDING THE SYSTEM LIBRARIES AND RESIDENT TASK CONFIGURATION

If a full system generation has been requested by the S form of an EDR directive (section 15.5.15), the library generator is loaded upon completion of nucleus processing. If only reconfiguration of resident tasks has been requested (R form of the EDR directive), the resident task configurator is loaded immediately after directive processing.

A **load module** is a logically complete task or operation that can be executed by the VORTEX system in foreground or background. It resides in the foreground or background library, or in the user library. Load modules are constructed from sets of binary object modules interspersed with alphanumeric control records. The control records indicate the beginning and end of data for incorporation into each load module, and specify certain parameters to the load module. The group of object modules and control records used to construct a load module is called a **load-module package (LMP)**. Figure 15-5 shows an LMP for a load module without overlays, and figure 15-6 shows an LMP for a load module with overlays. Each LMP runs from a SLM control record to an END control record, and includes all modules and records between the SLM and END.



NOTE:

* = Alphanumeric control record

Figure 15-5. Load Module Package for Module Without Overlays

There are five SGEN control records used in building the library:

•	SLM	Start load module
•	TID	Task-identification block specification
•	OVL	Overlay
•	ESB	End of segment
•	END	

Library processing consists of the automatic reading of control records and object modules from the SGL, and construction of the library from these inputs. The only manual operations are the addition and replacement of load modules. In these cases, follow the procedures given in sections 15.5.8 and 15.5.9, respectively.

Resident-task configuration takes place upon completion of library processing. All tasks specified by TSK directives (section 15.5.13) are copied from the foreground library into the VORTEX nucleus, thus becoming *resident tasks*. To change the resident-task configuration of a previously generated system, input the TSK directives followed by the R form of the EDR directive (section 15.5.15), thus bypassing nucleus and library processing and allowing the resident-task configurator to alter the existing system. **Note:** If a specified program is not found in the foreground library, configuration continues, but an appropriate message is output.

15.7.1 SLM (Start LMP) Directive

This directive indicates the start of an LMP. It has the general form

SLM,name

where **name** is the name of the LMP that begins with this directive.

Example: Indicate the start of the LMP named ABC.

```
SLM,ABC
```

15.7.2 TID (TIDB Specification) Directive

This directive contains the parameters necessary for the generation of the task-identification block required for each generated load module. The TID directive has the general form

TID,name,mode,ovly,lun

where

name is the name (one to six alphanumeric characters) of the task

mode is 1 if the task is a background task, or 2 if it is a foreground task

ovly is the number of overlay segments, or 0 if the task has no overlay segments, (note that the value 1 is invalid)

lun is the number of the logical unit onto which the task is to be cataloged

Once a TID directive is input and processed, object modules are input, processed, and output to the specified logical unit until the ESB directive (section 15.7.4) is found.

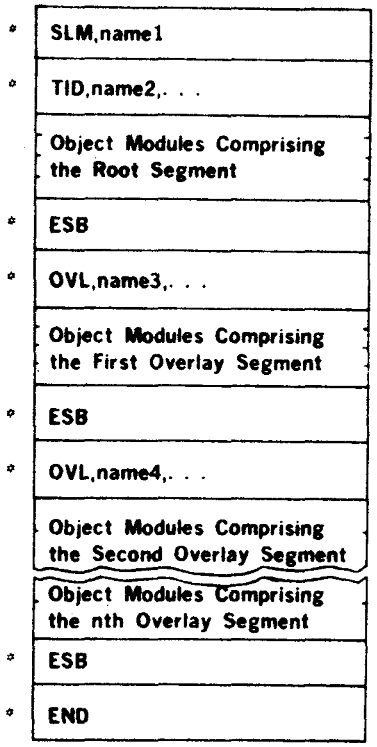
Examples: Specify a TIDB for a task PROG1 without overlays for cataloging on the BL unit (105).

```
TID,PROG1,1,0,105
```

Specify a TIDB for the task PROG2 with four overlay segments for cataloging on an FL unit (106).

```
TID,PROG2,2,4,106
```

Note: If a specified program is not found in the foreground library, configuration continues, but an appropriate message is output.



* SLM,name1

* TID,name2,. . .

Object Modules Comprising the Root Segment

* ESB

* OVL,name3,. . .

Object Modules Comprising the First Overlay Segment

* ESB

* OVL,name4,. . .

Object Modules Comprising the Second Overlay Segment

Object Modules Comprising the nth Overlay Segment

* ESB

* END

NOTE:

* = Alphanumeric control record

Figure 15-6. Load Module Package for Module With Overlays

15.7.3 OVL (Overlay) Directive

This directive indicates the beginning of an overlay segment. The OVL directive has the general form

OVL,segname

where **segname** is the name (one to six alphanumeric characters) of the overlay segment.

Example: Indicate the beginning of the overlay segment SINE.

```
OVL,SINE
```

15.7.4 ESB (End Segment) Directive

This directive indicates the end of a segment, i.e., that all object modules have been loaded and processed. The directive has the form

```
        ESB
```

The ESB directive causes the searching of the CL library, which was generated during nucleus processing, to satisfy undefined externals.

The ESB directive concludes both root segments (following TID, section 15.7.2) and overlay segments (following OVL, section 15.7.3) of a load module.

Example: Indicate the end of a segment.

```
ESB
```

15.7.5 END (End Library) Directive

This directive indicates the end of load-module generation. It has the form

```
        END
```

Example: Specify the end of load-module generation.

```
END
```

15.8 SYSTEM INITIALIZATION AND OUTPUT LISTINGS

Upon completion of load-module processing, SGEN outputs on the OC and LIS units the message

```
VORTEX SYSTEM READY
```

The system initializer and VORTEX nucleus are then loaded into memory, the initializer is executed to initialize the system, and the nucleus is executed to begin system operation. If writable control store is present in the system, the following messages will appear on the OC device at this time:

```
IO10,WCSRLD
FILE WCSIMG NOT FOUND
WCS RELOAD ABORTED
```

These messages are output by the WCS reload task. In WCS systems, this task is automatically scheduled upon loading the system in order to restore WCS contents. To do this, it uses the contents for WCS which were saved on a disc file the last time WCS was loaded. At this point, however, WCS has not yet been loaded. Thus, the reload task cannot restore WCS and exits after outputting the above messages. At this time, the OM library should be loaded and build on the RMD using FMAIN.

The OM library is provided as job streams as the second through thirty-fifth files on the SGL. An EOF separates the SGL from the OM stream. A system generation leaves magnetic tape and card SGLs prior to this EOF, thus it must be skipped over before executing the OM job stream. For disc SGLs the OM library object modules are on the second partition of the disc pack (DcuB). Refer to the VORTEX/VORTEX II Installation Manual for details.

The VORTEX system is now operating with the peripherals in the status specified by TID control records.

If the EDR directive specified a listing, linking information is listed on the LIS unit during nucleus processing and library generation. Regardless of the EDR directive, RMD and resident-task information is listed during nucleus processing or resident-task configuration, respectively. Figures 15-7 through 15-10 show the listing formats of load maps for the VORTEX nucleus, the library processor, the RMD partitions, and the resident tasks.

```
CORE RESIDENT LIBRARY

NAME               LOCATION

AAA                017285
BBB                021255
 .                    .
 .                    .
 .                    .
ZZZ                075777

NONSCHEDULED TASKS

NAME               LOCATION

TBABC              072620
TBDEF              074640
 .                    .
 .                    .
 .                    .
TBXYZ              076400
```

Figure 15-7. VORTEX Nucleus Load Map

```
SLM,BGTSKI
TID,JCP,1,0,105
ESB
MOP          A      032556
QRS          R      000200
 .           .         .
 .           .         .
 .           .         .
TUV          A      032501
SLM,FGTSKI
TID,V$OPCM,2,8,106
ESB
GHI          R      000010
JKL          R      000012
 .           .         .
 .           .         .
 .           .         .
MNO          R      000077
```

Figure 15-8. Library Processor Load Map

```
RMD PARTITIONING
NAME     FIRST        LAST         BAD
         TRACK        TRACK        TRACKS

D00A     0007         0008         0000
D00B     0009         0028         0000
D00C     0029         0053         0000
D00D     0054         0093         0000
D00E     0094         0101         0000
D00F     0102         0119         0000
D00G     0120         0137         0000
D00H     0138         0203         0000

D01A     0001         0039         0000
D01B     0040         0099         0000
D01C     0100         0149         0000
D01D     0150         0203         0000
```

Figure 15-9. RMD Partition Listing

```
MEMORY RESIDENT TASKS
NAME              LOCATIONS
PROG1             014630
PROG2             014630
PROG3             NOT FOUND
PROG4             014500
```

Figure 15-10. Resident-Task Load Map

```
PAGES (OCTAL)           ALLOCATED TO
                0  PAGE 0 SYSTEM DATA
      1  -     50  UNALLOCATED
     51  -     72  NUCLEUS PROGRAM MODULE
     72  -     75  NUCLEUS TABLE MODULE
               75  GLOBAL FCB PAGE
               75  FOREGROUND BLANK COMMON
    100  -    177  UNALLOCATED
VORTEX SYSTEM READY
```

Figure 15-11. Physical Memory Allocation

15.9 SYSTEM GENERATION EXAMPLES

EXAMPLE 1

Problem: Generate a VORTEX system using the following hardware:

a. Computer with 32K main memory

b. A model 70-7610 (620-37) disc unit with device address 016 on BIC 20

c. Teletype keyboard/printer

d. Card reader

e. Two buffer interlace controllers (BICs) with device addresses 020 and 022

f. One priority interrupt module (PIM) with device address 040

g. No writable control store

and having the characteristics listed below:

a. Foreground common size = 0200

b. Storage/reentry stack area size = 0200

c. Number of disc partitions = 9

d. All eight interrupt lines connected through a common interrupt handler 0 = BIC1, 1 = BIC2, 2 = CR, 3 = Disc seek, 4 = TY read, 5 = TY write, 6-7 unassigned

e. One user-coded task added to the resident module (PROG1)

f. JCP replaced with a new version

g. One user-coded load module added to the background library (after LMGEN) (PROG2)

h. The system file listed after system generation

Procedure:

Step	**User Action**	**SGEN Response**
1	Load and execute the card reader loader (table 15-1)	Loads the I/O interrogation routine punched cards from the card reader, and outputs on the OC unit **I/O INTERROGATION**
2	On the OC unit, input **DIR = TY00A,01** **LIB = CR00A,030** **ALT = CR00A,030** **LIS = TY00A,01** **SYS = D00B,016,020**	Loads the SGEN drivers and directive processor, and outputs **INPUT DIRECTIVES**
3	On the Teletype (DIR unit), type **CLK,100,100,20** **MRY,757777,0200,32** **EQP,D0B,016,1,020,3** **EQP,TY0A,01,1,0,0** **EQP,CR0A,030,1,022,0** **PRT,D00A,2,C;D00B,20,F** **PRT,D00C,25,E;D00D,40,D** **PRT,D00E,8,S;D00F,18,B** **PRT,D00G,18,*;D00H,52,*** **PRT,D00I,14,*** **ASN,1 = TY00,2 = TY00,3 = TY00** **ASN,4 = CR00,5 = TY00,6 = CR00** **ASN,7 = D00I,8 = D00H,9 = D00G** **ASN,10 = D00H,11 = TY00,12 = TY00** **ASN,180 = D00H,181 = D00I** **PIM,03,TBD0B,01,0;02,TBCR0A,01,0** **PIM,03,TBD0B,01,0;04,TBTY0A,01,0** **PIM,05,TBTY0A,02,0** **TSK,PROG1** **LRE,BJCP** **LAD,BLMGEN** **LDE,FMIUTI** **LDE,FMICSI** **LDE,FMIDAS** **LDE,FNCSRL** **EDR,S,20,0200,9,61,26,L**	Processes the directives, partitions the disc, loads the nucleus processor and builds the nucleus, loads the library processor and builds the library until load module JCP is encountered, and outputs **REPLACE BJCP** **READY**
4	Load revised version of BJCP load module in the card reader, and on DIR type: **ALT**	Reads and processes the new load module, and outputs: **READY**
5	Load the remainder of the load module library in the card reader, and on DIR type **LIB**	Processes the load module library until the completion of LMGEN, and outputs **ADD AFTER BLMGEN** **READY**
6	Load the PROG1 load module in the card reader, and on DIR type	Reads and processes PROG1, and outputs

Procedure: *(continued)*

Step	User Action	SGEN Response
	ALT	**READY**
7	Load the PROG2 load module in the card reader, and on DIR type **ALT**	Reads and processes PROG2, and outputs **READY**
8	Load the remainder of the load module library in the card reader, and on DIR type **LIB**	Processes the remainder of the load module library, copies PROG1 from the FL unit to the VORTEX nucleus, lists the resident task information, and outputs on OC and LIS **VORTEX SYSTEM READY**
9	None	Loads and initializes the VORTEX nucleus

EXAMPLE 2

Problem: Replace the current resident tasks in the foreground library with the tasks listed below in an operational VORTEX system. Assume the SGL is on magnetic tape unit 0. The system has a line printer and a 620-48 RMD on DA014. ALT is on the slave MT.

PROG1
ABC
TEST
EFG

Procedure:

Step	User Action	SGEN Response
1	Load and execute the magnetic tape loader (table 15-1)	Loads the I/O interrogation routine from magnetic tape and outputs from the OC unit **IO INTERROGATION**
2	On the OC unit, input **DIR = TY00A,01** **LIB = MT00A,010** **ALT = MT01A,010** **LIS = LP00A,035** **SYS = D00A2,014,020**	Loads the SGEN drivers and directive processor, and outputs **INPUT DIRECTIVES**
3	On the Teletype (DIR unit), type **TSK,PROG1,ABC** **TSK,TEST,EFG** **EDR,R**	Processes the directives, loads the resident-task processor, enters the PROG1, ABC, TEST, and EFG load modules from FL, lists resident information, and outputs on OC and LIS **VORTEX SYSTEM READY**
4	None	Loads and initializes the VORTEX nucleus

SECTION 16
SYSTEM MAINTENANCE

The VORTEX **system-maintenance component (SMAIN)** is a background task that maintains the **system-generation library (SGL)**. The SGL (figure 15-2) comprises all object modules and their related control records required to generate a generalized VORTEX operating system.

16.1 ORGANIZATION

SMAIN is scheduled for execution by inputting the job-control-processor (JCP) directive /SMAIN (section 4.2.21).

Once SMAIN is so scheduled, loaded, and executed, SMAIN directives can be input from the SI logical unit to maintain the SGL. No processing of the SGL takes place before all SMAIN directives are input and processed. Then user-specified object modules and/or control records are added, deleted, or replaced to generate a new SGL.

SMAIN has a symbol-table area for 200 symbols at five words per symbol. To increase this, input a /MEM directive (section 4.2.5), where each 512-word block will increase the capacity of the table by 100 symbols.

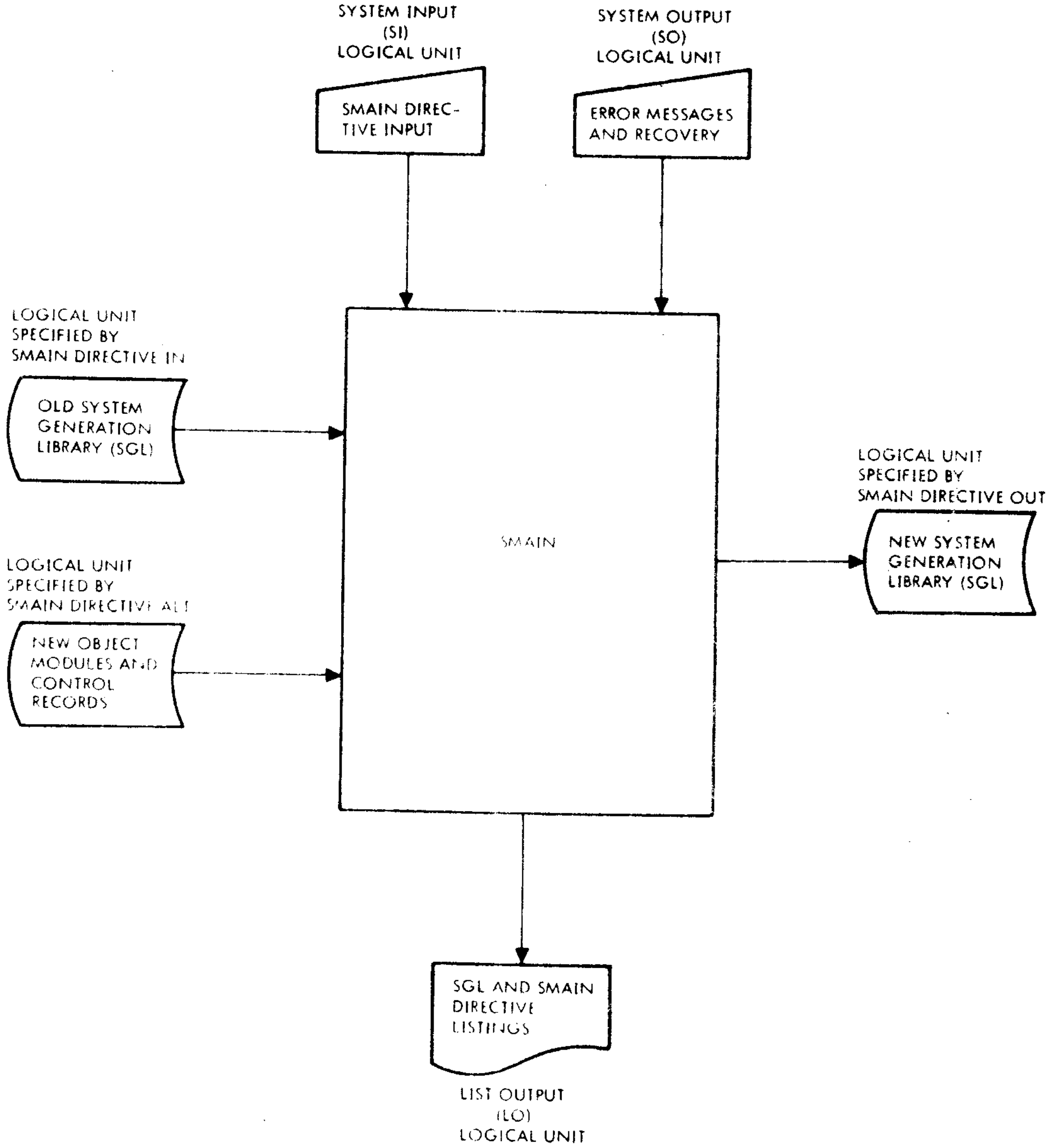


Figure 16-1. SMAIN Block Diagram

INPUTS to the SMAIN comprise:

a. *System-maintenance directives* (section 16.2) input through the SI logical unit.

b. *The old SGL* input through the logical unit specified by the IN directive (section 16.2.1).

c. *New or replacement object modules and/or control records* input through the logical unit specified by the ALT directive (section 16.2.3).

d. *Error-recovery inputs* entered via the SO logical unit.

System-maintenance directives specify both the changes to be made in the SGL, and the logical units to be used in making these changes. The directives are input through the SI logical unit and listed, when specified, on the LO logical unit. If the SI logical unit is a Teletype or a CRT device, the message **SM**** is output to indicate that the SI unit is waiting for SMAIN input.

The old **SGL** contains three types of records: 1) control records and comments (ASCII), 2) the system-generation relocatable loader and BOOTLODR (the only SGL absolute core-image records), and 3) relocatable object modules such as are output by the DAS MR assembler and the FORTRAN compiler.

New or replacement object modules and/or control records have the same specifications as their equivalents in the old SGL.

Error-recovery inputs are entered by the operator on the SO logical unit to recover from errors in SMAIN operations. Error messages applicable to this component are given Appendix A.16. Recovery from the type of error represented by invalid directives or parameters is by either of the following:

a. Input the character C on the SO unit, thus directing SMAIN to go to the SI unit for the next directive.

b. Input the corrected directive on the SO unit for processing. The next SMAIN directive is then input from the SI unit.

Recovery from errors encountered while processing object modules and/or control records is by either of the following:

a. Input the character R on the SO unit, thus directing a rereading and reprocessing of the last record.

b. Input the character P on the SO unit, thus directing a rereading and reprocessing from the beginning of the current object module or control record.

In the last two cases, repositioning is automatic if the error involves a magnetic-tape unit or an RMD. Otherwise, such repositioning is manual.

If recovery is not desired, input a JCP directive (section 4.2) on the SO unit to abort the SMAIN task and schedule the JCP for execution.

OUTPUTS from the SMAIN comprise:

a. *The new SGL*

b. *Error messages*

c. *The listing of the old SGL*, if requested

d. *Directive images*

The new SGL contains object modules and control records. It is similar in structure to the old SGL.

Error messages applicable to SMAIN are output on the SO and on LO logical units. The individual messages, errors, and possible recovery actions are given in Appendix A.16.

The listing of the old SGL is output, if requested, on the LO unit. The output consists of a list of all control records and the contents of all object modules. At the top of each page, the standard VORTEX heading is output.

The image of an object module is represented by the identification name of the module, the date the module was generated, the size (in words) of the module (0 for a FORTRAN object module), and the external names referenced by the module, in the following format:

```
id-name   date   size   entry-names   external-names
```

Directive images are posted onto the LO unit, thus providing a hardcopy of the SMAIN directives for permanent reference.

16.1.1 Control Records

In SMAIN there are two types of control record:

a. *SGL delimiters*

b. *Object-module delimiters*

SGL delimiters divide the SGL into five parts. Each part is separated from the following part by a control record of the form

```
CTL,PART000n
```

where n is the number of the following part, and the SGL itself is terminated by a control record of the form

```
CTL,ENDOFSGL
```

Within SMAIN directives, these control records are referenced in the following format

```
PART000n
ENDOFSGL
```

Object-module delimiters precede and/or follow each group of object modules within the SGL. Each delimiter is of one of the forms

```
SLM,name
TID,name
OVL,name
TDF,name
ESB
END
```

The control records containing a name can be referenced by use of the name alone in SMAIN directives. These control records and their uses are described in the section on the system-generator component (section 15).

A set of object modules preceded by an SLM control record and followed by an END control record is known as a **load-module package (LMP)**. To add, delete, or replace an entire LMP, merely reference the name associated with the SLM control record. Thus, if the directive specifies deletion and includes the name associated with the SLM record, the entire LMP is deleted. Additions and replacements operate analogously.

16.1.2 Object Modules

Relocatable object-module outputs from the DAS MR assembler and the FORTRAN compiler are described in appendix G.

16.1.3 System-Generation Library

The SGL is a collection of system programs in binary-object form, and of control records in alphanumeric form, from which a VORTEX system is generated. The structure of the SGL is described in section 15.

16.2 SYSTEM-MAINTENANCE DIRECTIVES

This section describes the SMAIN directives:

•	IN	Specify input logical unit
•	OUT	Specify output logical unit
•	ALT	Specify input logical unit for new SGL items
•	ADD	Add items to the SGL
•	REP	Replace SGL items
•	DEL	Delete items from the SGL
•	LIST	List the old SGL
•	END	End input of SMAIN directives

SMAIN directives begin in column 1 and comprise sequences of character strings having no embedded blanks. The character strings are separated by commas (,) or by equal signs (=). The directives are free-form and blanks are permitted between the individual character strings of the directive, i.e., before or after commas (or equal signs). Although not required, a period (.) is a line terminator. Comments can be inserted after the period.

The general form of an SMAIN directive is

name,*p(1)*,*p(2)*,...,*p(n)*

where

name is one of the directive names given above (any other character string produces an error)

each *p(n)* is a parameter defined below under the descriptions of the individual directives

Numerical data can be octal or decimal. Each octal number has a leading zero.

For greater clarity in the descriptions of the directives, optional periods, optional blank separators between character strings, and the optional replacement of commas (,) by equal signs (=) are omitted.

Error messages applicable to SMAIN directives are given in Appendix A.16.

16.2.1 IN (Input Logical Unit) Directive

This directive specifies the logical unit from which the old SGL is to be input. It has the general form

IN,**lun**,*key*,*filename*

where

lun is the name or number of the logical unit to be used for the input of the old SGL

key is the protection code, if any, required to address **lun**

filename is the name of the input file only when **lun** is an RMD partition with a directory

There is no default value for **lun**. If it is not specified, any attempt at SGL processing will cause an error message output.

Once specified, the value of **lun** remains constant until changed by a subsequent IN directive. Each change of **lun** requires a new IN directive.

If **lun** specifies an RMD partition, the RMD is rewound to the first sector following the start of the partition before any processing takes place.

Examples: The old SGL resides on logical unit 4, the PI unit. Specify this unit to be the SGL input unit.

```
IN,4
```

The old SGL resides on logical unit 107, which requires the protection code G. Specify this unit to be the SGL input unit. (This is a non-directoried partition.)

```
IN,107,G
```

16.2.2 OUT (Output Logical Unit) Directive

This directive specifies the logical unit on which the new SGL is to be output. It has the general form

OUT,lun,*key,filename*

where

lun is the name or number of the logical unit to be used for the output of the new SGL

key is the protection code, if any, required to address **lun**

filename is the name of the output file when **lun** is an RMD partition

The default value of **lun** is zero. When **lun** is zero by specification or by default, there is no output logical unit.

Once specified, the value of **lun** remains constant until changed by a subsequent OUT directive. Each change of **lun** requires a new OUT directive.

If **lun** specifies an RMD partition, the RMD is rewound to the first sector following the PST before any processing takes place. The PST comprises one entry defining the entire RMD.

Examples: Specify the PO logical unit, unit 10, to be the output unit for the new SGL.

```
OUT,10
```

Specify that there is to be no output logical unit.

```
OUT,0
```

16.2.3 ALT (Alternate Logical Unit) Directive

This directive specifies the logical unit from which new object module(s) and/or control record(s) are to be input to the new SGL. It has the general form

ALT,lun,*key,filename*

where

lun is the name or number of the logical unit to be used for the input of new items to the SGL

key is the protection code, if any, required to address **lun**

filename is the name of the input file when **lun** is an RMD partition

There is no default value for **lun**. If it is not specified, any attempt to input new object modules or control records to the SGL will cause an error message output.

Once specified, the value of **lun** remains constant until changed by a subsequent ALT directive. Each change of **lun** requires a new ALT directive.

Examples: Specify that new object modules and control records are to be input to the SGL from the BI logical unit only.

```
ALT,6
```

Make the same specification where BI is an RMD partition without a protection code. Use file FILEX.

```
ALT,BI,,FILEX
```

Note: $MAIN does not accept packed binary. Use IOUTIL to unpack binary if necessary.

16.2.4 ADD Directive

This directive permits the addition of object modules and/or control records during the generation of a new SGL, the additions being made immediately after each of the items specified by the parameters of the ADD directive. The directive has the general form

ADD,p(1),*p(2),...,p(n)*

where each **p(n)** is the name of an object module or control record after which additions are to be made.

SMAIN copies object modules and control records from the old SGL into the new SGL up to and including an item specified by one of the parameters, p(n), of the ADD directive. After this item is copied, the message

```
ADD AFTER p(n)
 SM**
```

is output to indicate that SMAIN is waiting for a control character (Y or N) to be input on the SO logical unit.

If the control character input is Y, SMAIN adds the next object module or control record contained on the logical unit specified by the ALT directive (section 16.2.3), then repeats the message requesting another control character. This continues until the control character input is N.

If the control character input is N, SMAIN assumes the additions at this point are complete. It continues copying from the old SGL and outputs the message

```
END REPLACEMENTS
```

The entire process is repeated when the next item specified by one of the parameters, p(n), of the ADD directive is found. The items in the directive need not be in the same order as they appear on the old SGL.

Example: During generation of a new SGL, add object module(s) and/or control record(s) after the old SGL control record PART0001 and after the old SGL object module LMP, the added items to be input from the logical unit specified by the ALT directive. Input

```
ADD,PART0001,LMP
```

then, when the message

```
ADD AFTER PART0001
 SM**
```

appears, input the control character Y. SMAIN then inputs the next item on the logical unit specified by the ALT directive, and again outputs the message

```
 SM**
```

and awaits another control character. If more is to be added here, input Y. If no more additions are required at this point, input N. After receiving the N, SMAIN outputs the message

```
END REPLACEMENTS
```

and continues to read the old SGL and copy it into the new SGL up to and including the object module LMP. SMAIN then outputs the message

```
ADD AFTER LMP
 SM**
```

at which time the process is repeated.

Note that PART0001 does not have to precede LMP in the old SGL. If the positions of the items are reversed relative to their order in the directive, the order of messages will be reversed. **In any case, the items on the logical unit specified by ALT must be in the order in which they are to be added to the SGL.**

16.2.5 REP (Replace) Directive

This directive permits the replacement of object modules and/or control records during generation of a new SGL. The directive has the general form

REP,*p*(1),*p*(2),...,*p*(*n*)

where each p(n) is the name of an object module or control record that is to be replaced.

SMAIN copies object modules and control records from the old SGL into the new SGL until it encounters one specified by one of the parameters, p(n), of the REP directive. SMAIN then reads the item to be replaced, but does not copy it into the new SGL. After this is completed, the message

```
REPLACE p(n)
 SM**
```

is output to indicate that SMAIN is waiting for a control character (Y or N) to be input on the SO logical unit. These control characters operate just as in the ADD directive (section 16.2.4), allowing the addition (in this case, replacement, since the parameter item was not copied into the new SGL) of new items to the SGL. The items in the directive need not be in the same order as they appear in the old SGL.

Example: During generation of a new SGL, replace the old SGL object module IOCTL with object modules and/or control records from the logical unit specified by an ALT directive (section 16.2.3). Input

```
REPLACE,IOCTL
```

then, when the message

```
REP IOCTL
 SM**
```

appears, continue as for an ADD directive (section 16.2.4).

16.2.6 DEL (Delete) Directive

This directive permits the deletion of object modules and/or control records during generation of a new SGL. The directive has the general form

DEL,*p*(1),*p*(2),...,*p*(*n*)

where each p(n) is the name of an object module or control record that is to be deleted.

SMAIN copies object modules and control records from the old SGL into the new SGL until it encounters one specified by one of the parameters, p(n), of the DEL directive. SMAIN then reads the item to be deleted, but does not copy it into the new SGL. The items in the DEL directive need not be in the same order as they appear on the old SGL.

If a listing of the old SGL is specified either by a LIST directive (section 16.2.7) or by the L parameter of an END directive (16.2.8), the deleted items are preceded on the listing by asterisks (*).

Example: During generation of a new SGL, delete the following old SGL items: object module IOST and control record LMGENCTL.

```
DEL,IOST,LMGENCTL
```

16.2.7 LIST Directive

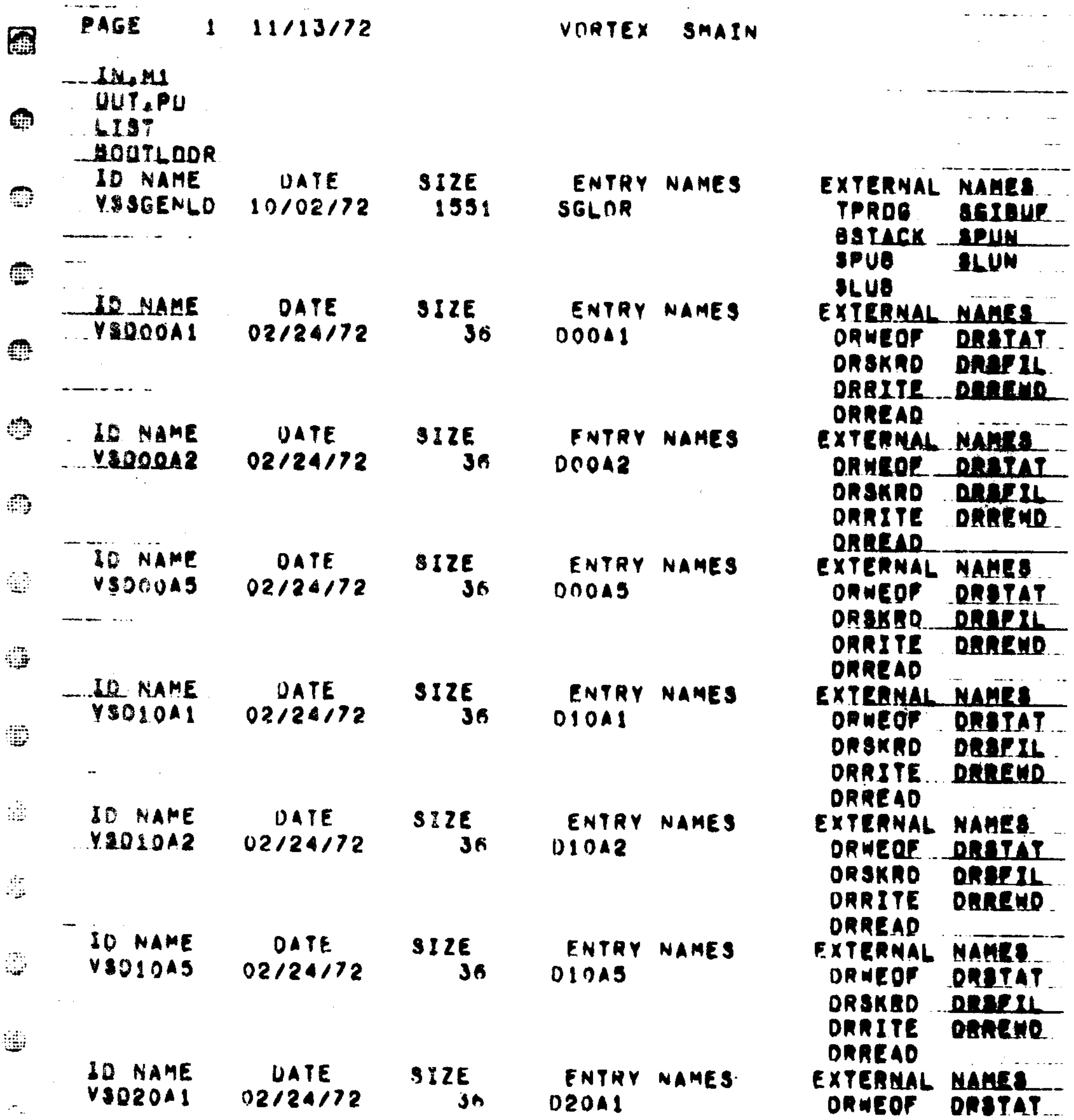
This directive lists, on the LO logical unit, the old SGL as found on the logical unit specified by the SMAIN directive IN (section 16.2.1). The LIST directive has the form

LIST

Example: List the old SGL.

```
LIST
```

Figure 16-2 shows the format of output from this directive.



```
 PAGE     1   11/13/72                  VORTEX  SMAIN

  IN,M1
  OUT,PU
  LIST
  BOOTLDDR
  ID NAME     DATE      SIZE      ENTRY NAMES        EXTERNAL NAMES
  VSSGENLD  10/02/72    1551     SGLDR                TPROG     SGIBUF
                                                      BSTACK    SPUN
                                                      SPUB      SLUN
                                                      SLUB
  ID NAME     DATE      SIZE      ENTRY NAMES        EXTERNAL NAMES
  VSD00A1   02/24/72      36     D00A1                DRWEOF    DRSTAT
                                                      DRSKRD    DRSFIL
                                                      DRRITE    DRREND
                                                      DRREAD
  ID NAME     DATE      SIZE      ENTRY NAMES        EXTERNAL NAMES
  VSD00A2   02/24/72      36     D00A2                DRWEOF    DRSTAT
                                                      DRSKRD    DRSFIL
                                                      DRRITE    DRREND
                                                      DRREAD
  ID NAME     DATE      SIZE      ENTRY NAMES        EXTERNAL NAMES
  VSD00A5   02/24/72      36     D00A5                DRWEOF    DRSTAT
                                                      DRSKRD    DRSFIL
                                                      DRRITE    DRREND
                                                      DRREAD
  ID NAME     DATE      SIZE      ENTRY NAMES        EXTERNAL NAMES
  VSD10A1   02/24/72      36     D10A1                DRWEOF    DRSTAT
                                                      DRSKRD    DRSFIL
                                                      DRRITE    DRREND
                                                      DRREAD
  ID NAME     DATE      SIZE      ENTRY NAMES        EXTERNAL NAMES
  VSD10A2   02/24/72      36     D10A2                DRWEOF    DRSTAT
                                                      DRSKRD    DRSFIL
                                                      DRRITE    DRREND
                                                      DRREAD
  ID NAME     DATE      SIZE      ENTRY NAMES        EXTERNAL NAMES
  VSD10A5   02/24/72      36     D10A5                DRWEOF    DRSTAT
                                                      DRSKRD    DRSFIL
                                                      DRRITE    DRREND
                                                      DRREAD
  ID NAME     DATE      SIZE      ENTRY NAMES        EXTERNAL NAMES
  VSD20A1   02/24/72      36     D20A1                DRWEOF    DRSTAT
```

Figure 16-2. SMAIN LIST Directive Listing

16.2.8 END Directive

This directive indicates that all ADD (section 16.2.4), REP (section 16.2.5), and DEL (section 16.2.6) directives have been input. END initiates the SGL maintenance process. The directive has the general form

```
END,L
```

where *L*, if present, specifies that the old SGL is to be listed.

Examples: After all ADD, REP, and DEL directives have been input, initiate SGL maintenance processing.

```
END
```

Initiate the SGL maintenance processing as above, but list the old SGL.

```
END,L
```

16.3 SYSTEM-MAINTENANCE OPERATION

The normal SMAIN operation consists of copying an existing SGL from the logical unit specified by the IN directive (section 16.2.1) to the logical unit specified by the OUT directive (section 16.2.2), making the modifications specified by the ADD (section 16.2.4), REP (section 16.2.5), and DEL (section 16.2.6) directives, and thus creating a new SGL.

Input of the END directive (section 16.2.8) initiates the copying process. All ADD, REP, and DEL directives, if any, must precede the END directive.

Modifications to the SGL are made through the logical unit specified by the ALT directive (section 16.2.3). Such modifications are in the form of additions and/or replacements of object modules and/or control records. (These items can also be deleted, but this process does not, of course, require input on the ALT unit.)

When an object module is input, SMAIN verifies that there is no error with respect to check-sum, record size, loader codes, sequence numbers, or structure.

16.4 PROGRAMMING EXAMPLES

Example 1: Schedule SMAIN, copy the old SGL from logical unit 4 onto logical unit 9 without listing the old SGL, and return to the JCP.

```
/SMAIN
IN,4
OUT,9
END
/ENDJOB
```

Example 2: Schedule SMAIN; copy the old SGL from logical unit 4 onto logical unit 9, listing the old SGL and deleting object modules A, B, C, D, and E; and return to the JCP.

```
/SMAIN
IN,4
OUT,9
DEL,A
DEL,B,C,D,E
END,L
/ENDJOB
```

Example 3: Schedule SMAIN, list the contents the old SGL on logical unit 4, and return to the JCP.

```
/SMAIN
IN,4
LIST
/ENDJOB
```

Example 4: Schedule SMAIN; copy the old SGL from logical unit 4 onto logical unit 9 without listing the old SGL; add object modules or control records from logical unit 6 after control record PART0002 and after object module A; replace load module LMGEN and control record JCPDEF; delete object modules B, C, D, and E; and return to the JCP.

```
/SMAIN
IN,4
OUT,9
ALT,6
ADD,PART0002,A
REP,LMGEN
DEL,B,C,D,E
REP,JCPDEF
END
/ENDJOB
```

SECTION 17
OPERATOR COMMUNICATION

The operator communicates with the VORTEX system through the **operator communication component** by means of *operator key-in requests* input through the *operator communication (OC) logical unit*.

17.1 DEFINITIONS

An **operator key-in request** is a string of up to 80 characters beginning with a semicolon. The request is initiated by the operator and is input through the OC unit. An operator key-in request is independent of I/O requests via the IOC (section 3) and, hence, is known as an *unsolicited request*.

The **operator communication (OC) logical unit** is the logical unit through which the operator inputs key-in requests. There is only one OC unit in the VORTEX system. Initially, the OC unit is the first Teletype, but this assignment can be changed by use of the ;ASSIGN key-in request (section 17.2.9).

17.2 OPERATOR KEY-IN REQUESTS

This section describes the operator key-in requests:

•	;SCHED	Schedule foreground task
•	;TSCHED	Time-schedule foreground task
•	;ATTACH	Attach foreground task to PIM line
•	;RESUME	Resume task
•	;TIME	Enter or display time-of-day
•	;DATE	Enter date
•	;ABORT	Abort task
•	;TSTAT	Test task status
•	;ASSIGN	Assign logical unit(s)
•	;DEVDN	Device down
•	;DEVUP	Device up
•	;IOLIST	List logical-unit assignments

Operator key-in requests comprise sequences of character strings having no embedded blanks. The character strings are separated by commas (,) or by equal signs (=). However, the key-in requests are free-form and blanks are permitted between the individual character strings of the key-in request, i.e., before or after commas (or equal signs). Although not required, a period (.) is a line terminator. Comments can be inserted after the period. A carriage return is required to terminate any key-in request, however, regardless of whether it contains a period.

The general form of an operator key-in request is

;request,*p(1)*,*p(2)*,,...,*p(n)*cr

where

request is one of the key-in requests listed above in capital letters

each *p(n)* is a parameter defined under the descriptions of the individual key-in requests below

cr is the carriage return, which terminates all operator key-in requests

Each operator key-in request begins with a semicolon (;) and ends with a carriage return. Parameters are separated by commas. A backarrow (←) deletes the preceding character. A backslash (\) deletes the entire present key-in request.

Table 17-1 shows the system names of physical I/O devices as used in operator key-in requests.

Peripherals for data communication are not used in OPCOM request, but are controlled with the Network Control Module (NCM) described in the VTAM Reference Manual.

For greater clarity, optional blank separators between character strings, and the optional replacement of commas (,) by equal signs (=) are omitted from the descriptions of the key-in requests.

Error messages applicable to operator key-in requests are given in Appendix A.17.

Table 17-1. Physical I/O Devices

System Name	Physical Device
DUM	Dummy
CPcu	Card punch
CRcu	Card reader
CTcu	Cathode ray tube (CRT) device
Dcup	Rotating-memory device (RMD) (disc/drum)
LPcu	Line printer or Statos-31/33
MTcu	Magnetic tape unit
PTcu	High-speed paper tape reader/punch
TYcu	Teletype printer/keyboard
CLmA, COmA	Process I/O

Table 17-1. Physical I/O Devices *(continued)*

System Name	Physical Device
MXcu	Communication Multiplexor
TCco	Psuedo TCM
SPco	Spool Unit

NOTES

c = Controller number. For each type of device, controllers are numbered from 0 as required.

u = Unit number. For each controller, units are numbered from 0 as required (within the capacity of the controller).

cu can be omitted to specify unit 0 controller 0, e.g., CR00 or CR.

p = Partition letter. RMD partitions are lettered from A to T as required to refer to a partition on the specified device, e.g., D00A.

m = Multiplexor number

17.2.1 ;SCHED (Schedule Foreground Task) Key-In Request

This key-in request immediately schedules the specified foreground-library task for execution at the designated priority level. It has the general form

;SCHED,task,level,lun,*key*

where

task is the name of the foreground task to be scheduled

level is the priority level (from 2 to 31) of the scheduled task

lun is the number or name of the foreground-library rotating-memory logical unit where the scheduled task resides (0 for scheduling a resident foreground task)

key is the protection code, if any, required to address **lun**

A dump of the contents of a library can be obtained by use of the VORTEX file-maintenance component (section 9).

Operator key-in examples: Schedule on priority level 3 the foreground task DOTASK residing on the FL logical unit. Use F as the protection key.

```
;SCHED,DOTASK,3,FL,F
```

Schedule on priority level 9 the resident foreground task COPYIO.

```
;SCHED,COPYIO,9,0
```

17.2.2 ;TSCHED (Time-Schedule Foreground Task) Key-In Request

This key-in request schedules the specified foreground-library task for execution at the designated time-of-day and priority level. It has the general form

;TSCHED,task,level,lun,*key***,time**

where

task is the name of the foreground task to be scheduled

level is the priority level (from 2 to 31) of the scheduled) task

lun is the number or name of the foreground-library rotating-memory logical unit where the scheduled task resides (0 for scheduling a resident foreground task)

key is the protection code, if any, required to address **lun**

time is the scheduled time in hours (from 00 to 23) and minutes (from 00 to 59), e.g., 1945 for 7:45 p.m.

Operator key-in examples. Schedule for execution at 11:30 p.m. on priority level 3 the foreground task DOTASK residing on the US logical unit. Use T as the protection key.

```
;TSCHED,DOTASK,3,US,T,2330
```

Schedule for execution at 8:30 a.m. on priority level 9 the resident foreground task TESTIO.

```
;TSCHED,TESTIO,9,0,0830
```

17.2.3 ;ATTACH Key-In Request

This key-in request attaches the specified foreground task to the designated PIM (priority interrupt module) line. It has the general form

;ATTACH,task,line,iew,*enable*

where

task is the name of the foreground task to be attached to the PIM line

line is the two-digit number of the PIM line to which the task is to be attached, with the tens digit specifying the PIM number (0-7) and the units digit the line number (0-7) on that PIM

iew is the value (from 01 to 0177777) of the interrupt event word (section 14 or appendix F) and identifies the bit(s) to be set in the task TIDB when an interrupt occurs on **line**

enable is E (default value) to enable the line, or D to disable it

The **task** can be resident or nonresident. However, its TIDB must have been defined at system-generation time. ATTACH provides a flexible way of altering interrupt assignments without having to regenerate the system.

Operator key-in example: Connect task INTRPT to PIM 0, line 3. Use 020 as the interrupt event word value (i.e., set bit 4 of the interrupt event word in TIDB if INTRPT is scheduled due to an interrupt on PIM 0, line 3).

```
;ATTACH,INTRPT,03,020
```

A PIM directive with the PIM line to be attached must have been specified during system generation to set up the link to the interrupt line handler region.

Note: This directive detaches the PIM from a previous task.

17.2.4 ;RESUME Key-In Request

This key-in request reactivates the specified task for execution at its specified priority level. It has the general form

;RESUME,task

where **task** is the name of the task to be resumed

Operator key-in example: Resume the task DOTASK.

```
;RESUME,DOTASK
```

17.2.5 ;TIME Key-In Request

This key-in request enters the specified time, if any, as system time-of-day. If no time is specified in the key-in request, ;TIME displays the current time-of-day. The key-in request has the general form

;TIME,*time*

where ***time*** **is the time-of-day in hours (from 00 to 23) and minutes (from 00 to 59), e.g., 1945 for 7:45 p.m.**

The time-of-day output for a ;TIME request without *time* is of the form

```
T      hhmm      HRS
```

where hhmm is the time of day in hours and minutes.

Operator key-in example: Set the system time-of-day to 3:00 p.m.

```
;TIME,1500
```

17.2.6 ;DATE Key-In Request

This key-in request enters the specified date as the system date. It has the general form

;DATE,mm/dd/yy

where

mm is the month (01 to 12)

dd is the day (01 to 31)

yy is the year (00 to 99)

Note that since the entire date is considered one parameter, there are no commas other than the one immediately following **DATE**. The components of the date are, however, separated by slashes as shown. VORTEX does not support date roll-over.

Operator key-in example: Set the system date to 25 December 1971.

```
;DATE,12/25/71
```

17.2.7 ;ABORT Key-In Request

This key-in request aborts the specified task. It has the general form

;ABORT,task

where **task** is the name of the task to be aborted

Operator key-in example: Abort the task DOTASK.

```
;ABORT,DOTASK
```

17.2.8 ;TSTAT (Task Status) Key-In Request

This key-in request outputs the status of the specified task, if any. If no task is specified, ;TSTAT outputs the status of all tasks queued on the active task identification block (TIDB) stack. This request is not applicable to tasks having no established TIDB. The request has the general form

;TSTAT,*task*

where *task* is the name of the task whose status is to be output.

The status-output for a ;TSTAT key-in request is of the form

task Plevel Sstatus *TMmin TSmilli*

where

task is the name of the task whose status is being output

level is the priority level (from 0 to 31) of the task

status is the status of the task as found in words 1 and 2 of the TIDB (table 17 2)

min is the value of the counter in TIDB word 11

milli is the value of the counter in TIDB word 10

The values of min and milli are printed only if bit 6 and/or 7 of TIDB word 1 (table 17-2) is set.

Table 17-2. Task Status (TIDB Words 1 and 2)

TIDB Word	Bit	Meaning of Set Bit
1	15	Suspend interrupt
1	14	Suspend task
1	13	Abort task
1	12	Exit from task
1	11	TIDB resident
1	10	Resident task
1	9	Foreground task
1	8	Protected task
1	7	Task scheduled by time-delay
1	6	Time-delay active
1	5	Task waiting to be loaded (check pointed)
1	4	Task error
1	3	Task interrupt expected
1	2	Overlay task
1	1	Scheduled task upon termination of active task
1	0	Task search-allocated-loaded
2	15	Task opened, but not loaded
2	14	Task loaded in background (checkpoint) area
2	13	Load overlay
2	12	Background checkpoint I/O wait
2	11	Allocation override flag
2	10	Background being checkpointed
2	9	TIDB not available
2	8	Unused
2	7	Unused
2	6	Delay type 3 request
2	5-0	Task priority level

Operator key-in examples: Request the output of the status of the task BIGJOB.

```
;TSTAT,BIGJOB
```

The output will be

```
BIGJOB P02 S000100, 000000 TM077777 TS077430
```

if the status BIGJOB is such that it is on priority level 2, contains a status of 0100 in TIDB words 1 and 2, with time counters (TIDB words 1 and 10) of 077777 and 077430, respectively. The latter two octal complement counters show zero minutes and 0347 5-millisecond increments.

Request the output of the status of all active tasks.

```
;TSTAT
```

and receive as a typical response

```
VZDB     P24     S047401,   000000
V$TYA    P23     S047411,   000000
V$TYA    P23     S047411,   000000
VZLPA    P22     S047401,   000000
VZCRA    P22     S047401,   000000
```

```
VZMTA      P22       S047401,   000000
VZMTA      P22       S047401,   000000
V$OPCM     P10       S005405,   020000
PROG1      P05       S041501,   000000
JCP        P01       S044400,   000000
```

17.2.9 ;ASSIGN Key-In Request

This key-in request equates and assigns particular logical units to specific I/O devices. It has the general form

;ASSIGN,l(1) = r(1),*l(2)* = *r(2),...,l(n)* = *r(n)*

where

each **l(n)** is a logical-unit number (e.g., 12) or name (e.g., SI)

each **r(n)** is a logical-unit number or name, or a physical-device system name (e.g., TY00 or TY, table 17-1)

The logical unit to the left of the equal sign in each pair is assigned to the unit/device to the right

An inoperable device, i.e., one declared down by ;DEVDN (section 17.2.10), cannot be assigned. A logical unit designated as unassignable (unit numbers 101 through 179) cannot be reassigned.

Operator key-in examples: Assign the card reader CR00 as the SI logical unit and the Teletype TY01 as the OC unit.

```
;ASSIGN,SI=CR00,OC=TY01
```

Assign a dummy device as the PI unit

```
;ASSIGN,PI=DUM
```

17.2.10 ;DEVDN (Device Down) Key-In Request

This key-in request declares the specified physical device inoperable for system use. It is not applicable to the OC unit or to devices containing system libraries. The request has the general form

;DEVDN,device

where **device** is the system name of the physical device in four ASCII characters, e.g., LP00 (or LP), TY01, (table 17-1)

Operator key-in example; Declare TY01 inoperable for system use.

```
;DEVDN,TY01
```

17.2.11 ;DEVUP (Device Up) Key-In Request

This key-in request declares the specified physical device operational for system use. It has the general form

;DEVUP,device

where **device** is the system name of the physical device in four ASCII characters, e.g., LP00 (or LP), TY01 (table 17-1)

Operator key-in example: Declare TY02 operational for system use.

```
;DEVUP,TY02
```

17.2.12 ;IOLIST (List I/O) Key-In Request

This key-in request outputs a listing of the specified logical-unit assignments, if any. If no logical unit is specified, ;IOLIST outputs all logical-unit assignments with names. The key-in request has the general form

;IOLIST,*lun(1),lun(2),...,lun(n)*

where each *lun(n)* is the name or number of a logical unit, e.g., SI,5.

Where the ;IOLIST key-in request specifies a logical-unit name, the output is of the form

name (number) = device *D*

where

name is the name of the logical unit, e.g., LO

number is the number of that logical unit, e.g., 005

device is the name of the physical device assigned, e.g., LP00

D if present, indicates that the physical device has been declared down and is thus inoperable

If the key-in request specifies the number rather than the name of the logical unit, the output will repeat the number in both the **name** and **number** fields.

In a listing of all assignments, the output uses a name and number where applicable. Logical units without names assigned at system-generation time are not listed and must be individually specified by number.

Operator key-in examples: Request the output of the logical-unit assignments for the BI and BO units. Input

```
;IOLIST,BI,BO
```

and receive as a typical response

```
     BI (006) = CR00
     BO (007) = CP00 D
```

Request the output of the logical-unit assignment for logical unit 180. Input

```
;IOLIST,180
```

and receive as a typical response

```
     180 (180) = D11H
```

Request the output of all logical-unit assignments. Input

```
;IOLIST
```

and receive as a typical response

```
     OC (001) = TY00
     SI (002) = TY00
     SO (003) = TY00
     PI (004) = CR00 D
     LO (005) = LP00
     BI (006) = CR00 D
     BO (007) = PT00
     SS (008) = D00H
     PO (009) = D00H
     CU (100) = D00E
     GO (101) = D00G
     SW (102) = D00F
     CL (103) = D00A
     OM (104) = D00D
     BL (105) = D00C
     FL (106) = D00B
```

SECTION 18
OPERATION OF THE VORTEX SYSTEM

This section explains the operation of devices in the VORTEX system, the loading of the system bootstrap loading and initializing of writable control store and procedures for changing and initializing the disc pack during VORTEX operation.

18.1 DEVICE INITIALIZATION

18.1.1 Card Reader
(Model 70-6200)

a. Turn on the card reader.

b. Place the input deck in the card hopper.

c. Press READY/ALERT.

18.1.2 Card Punch
(Model 70-6200)

a. Turn on the card punch.

b. Place blank cards in the card hopper.

c. If the visual punch station is empty, insert a card into it as follows:

(1) Place a card in the auxiliary feed slot.

(2) Clear all registers.

(3) Set the instruction register I to 0100131.

(4) Set REPEAT.

(5) Press STEP. The card should move from the auxiliary feed slot to the visual punch station.

(6) Reset REPEAT.

18.1.3 Line Printer
(Model 70-6701)

a. Turn on the line printer.

b. Wait for the READY light to come on.

c. Set the ON LINE/OFF LINE switch to ON LINE.

d. For manual paper ejection set to OFF LINE, then press the TOP OF FORM switch.

18.1.4 Statos-31 *(Model 70-6602 and -6603)*

a. Turn on plotter/printer

b. Set the ON LINE/OFF LINE switch to ON LINE

c. Select roll or z-fold paper switch for paper type used

d. For manual form feed press FORM FEED

18.1.5 33/35 ASR Teletype
(Models 70-6200 and 6201

a. Turn on the Teletype.

b. Set the Teletype in off-line mode and simultaneously press the CONTROL and D, then the CONTROL and T, finally the CONTROL and Q keys.

c. Set the Teletype on-line.

18.1.6 High-Speed Paper-Tape Reader
(Model 70-6320)

a. Turn on the paper-tape reader.

b. Position the input paper tape in the reader with blank leader at the reading station and close the reading gate.

c. Set the LOAD/RUN switch to RUN.

18.1.7 Magnetic-Tape Unit
(Models 70-7100,-7102, and 620-31

a. Turn on the magnetic-tape unit.

b. Mount the input magnetic tape.

c. Position the magnetic tape to the loading point.

d. Press ON LINE.

18.1.8 Magnetic-Drum and Fixed-Head Disc Units
(Models 620-47 through 620-49,
70-7702 and 70-7703

a. Turn on the drum unit.

b. Wait for the drum unit to reach operating speed.

18.1.9 Moving-Head Disc Units
(Models 70-7600 and 70-7610

a. Place the START/STOP switch in the STOP position.

b. Press POWER ON button and wait for the SAFE light to come on.

c. Mount the disc pack.

d. Place the START/STOP switch in the START position.

e. Wait for the disc unit to reach operating speed (READY indicator lights).

f. Turn off WRITE PROTECT.

18.1.10 Moving-Head Disc Units

(Model 70-7500)

a. Mount the disc pack

b. Press POWER-ON button and wait for unit to reach operating speed and for the heads to emerge

c. Press on-line button.

18.1.11 Moving-Head Disc Units

(Model 70-7510)

a. Mount the disc pack(s).

b. Turn power on and wait for the unit(s) to reach operating speed (unit-ready light comes on).

18.1.12 Moving-Head Disc Units

(Models 70-7603, 70-7613)

a. Mount disc pack.

b. Press START button and wait for Ready light.

18.2 SYSTEM BOOTSTRAP LOADER

System key-in loaders initiate loading of the VORTEX system from a drum or disc memory. The key-in loader loads the system initializer from the RMD to main memory (locations 000000 to 001127). The system initializer then loads and initializes the system. Table 18-1 contains the key-in loader programs.

Table 18-1. Key-In Loader Programs

Address	Drum -48,49	Disc 70-7510	Disc 70-7500	Disc 70-7600, -7610, -7603 or 7613
001130	1000yy	005302	005302	1004zz INIT C.
001131	006020	006030	006030	1040zz Sel y(0)
001132	000002	000005	177773	1002zz
001133	005001	005001	005001	005001
001134	1031xx	1000zz	1000zz	1031zz
001135	006120	1031zz	1031zz	1010zz
001136	001127	1005zz	1005zz	001141
001137	1031yy	1010zz	1010zz	001000
001140	1000xx	001143	001143	001135
001141	1000zz	001000	001000	1025zz

Table 18-1. Key-In Loader Programs *(continued)*

Address	Drum -48,49	Disc 70-7510	Disc 70-7500	Disc 70-7600, -7610, -7603 or 7613
001142	1032zz	001137	001137	151167
001143	1010xx	1025zz	1025zz	001016
001144	000600	001016	001016	001130
001145	001000	001200	001130	1000yy
001146	001143	005123	005122	1003zz
001147		006120	005021	005102
001150		000167	006120	1032zz
001151		004460	000167	1031xx
001152		1000zz	004460	006010
001153		1000yy	1000zz	001130
001154		1031xx	1000yy	1031yy
001155		1032yy	1031xx	1000xx
001156		1000xx	1032yy	1000zz
001157		005041	1000xx	1014zz
001160		1031zz	005041	001157
001161		1004zz	006150	1025zz
001162		1014zz	000007	151167
001163		001166	1031zz	001016
001164		001000	1004zz	001130
001165		001162	1014zz	001000
001166		1025ZZ	001171	000600 ←
001167		001016	001000	007760
001170		000120	001165	
001171		005145	1025ZZ	
001172		006140	001016	
001173		000012	001130	
001174		001002	005144	
001175		000600	001040	
001176		001000	000600	
001177		001146	001000	
001200		000000	001146	

where xx = even BIC address, yy = odd BIC address, and zz = device address.

18.2.1 Automatic Bootstrap Loader

Where the automatic bootstrap loader option is available, the appropriate key-in loader is loaded from the required medium (high-speed paper-tape or Teletype reader) into locations starting with 001130. If the system contains a V70 RMD ABL the boot program is automatically loaded and executed. (Boot addr.)

To initiate the loader: (1) clear the A, B, X, I, and P registers; (2) with the computer in STEP, press the RESET switch on the front panel; (3) place the STEP/RUN switch in the RUN position; and (4) press and release the LOAD switch.

18.2.2 Control Panel Loading

The appropriate key-in loader is entered through the computer control panel. Refer to the hardware handbook for details.

To initiate the bootstrap, clear the A, B, X, and I registers, and load 001130 into the P register. Then, press RESET, place the STEP/RUN switch in the RUN position, and press START. See section 15.8 and 20.1.4 for details as system initialization messages.

NOTE: To facilitate reloading, the key-in loader may be dumped out on paper tape and then loaded by the binary loader (BLD II).

18.3 DISC PACK HANDLING

VORTEX provides for dynamic mounting of disc packs during program execution by means of a system utility program called **rotating memory analysis and initialization** (**RAZI**). RAZI handles:

a. A disc pack not previously used with VORTEX that is replacing a disc pack presently in the system.

b. A disc pack previously formatted under VORTEX that is replacing a disc pack presently in the system.

The normal RAZI operating procedure is:

a. The task requiring the disc pack change issues an operator message directing him to switch packs.

b. The task suspends itself.

c. The operator makes the necessary pack changes.

d. The operator schedules and executes RAZI.

e. Upon completion of RAZI, the operator resumes the suspended task. The task can now perform I/O on the new pack.

RAZI is a foreground program residing in the foreground library (FL). It is scheduled by a request of the form:

;SCHED,RAZI,p,FL,F

where **p** is the priority level.

If the SI logical unit is a Teletype or a CRT device, the message **RZ**** is output to indicate that the SI unit is waiting for RAZI input.

Each directive is completely processed before the next is entered. All directives are output on the SO device. In addition, partitioning information is listed on the LO device when integration of the requested disc pack is complete.

OUTPUTS from the RAZI comprise:

a. *Error messages*

b. *The listing of the RAZI directives on the SO unit*

c. *Partition description listing*

Error messages applicable to RAZI are output on the SO and LO logical units. The individual messages and errors are given in Appendix A.18.

The partition description listing is output on the LO device upon completing the integration of a new disc pack into the VORTEX system. After the VORTEX standard heading, there are three blank lines followed by the RAZI heading:

```
PARTITION        FIRST       LAST      BAD
NAME             TRACK       TRACK     TRACKS
```

followed by one more blank line. Then the information concerning each partition of the device is output, one partition per line, as shown in the following example.

```
PARTITION        FIRST       LAST      BAD
NAME             TRACK       TRACK     TRACKS

D10A             0002        0019      0000
D10B             0020        0052      0001
D10C             0053        0082      0000
D10D             0083        0118      0000
D10E             0119        0126      0000
D10F             0127        0141      0000
D10G             0142        0156      0000
D10H             0157        0206      0002
D10I             0207        0242      0000
D10J             0243        0251      0000
D10K             0252        0256      0000
```

The RAZI directives are:

•	PRT	Partition
•	FRM	Format rotating memory
•	INL	Initialize
•	EXIT	Exit

RAZI directives begin in column 1 and comprise sequences of character strings having no embedded blanks. The character strings are separated by commas (,) or equal signs (=). The directives are free-form, and blanks are permitted between the individual character strings of the directive, i.e., before or after commas (or equal signs).

The general format of a RAZI directive is

name,*p(1),p(2),...,p(n)*

where

name is one of the directive names given above

each *p(n)* is a parameter required by the directive and defined below under descriptions of the individual directives

Numerical data can be octal or decimal. Each octal number has a leading zero.

For greater clarity in the descriptions of the directives, optional periods, optional blank separators between character strings, and the optional replacement of commas (,) by equal signs (=) are omitted.

Note: The disc pack containing the VORTEX nucleus cannot be replaced.

18.3.1 PRT (Partition) Directive

This directive specifies the size and protection code for each RMD partition. It has the general form

PRT,p(1),s(1),k(1),*p(2),s(2),k(2),...,p(n),s(n),k(n)*

where

each *p(n)* is the RMD partition letter (A through T, inclusive)

s(n) is the number (octal or decimal) of tracks in the partition. This value must be greater than zero.

k(n) is the protection code, if any, required to address p, or * if the partition is unprotected

While the partition specifications can appear in any order, the set of partitions specified for each RMD must comprise a contiguous group, e.g., the sequence A, C, D, B is valid but, the sequence A, C, D, E constitutes an error.

Consecutive PRT directives redefine partitions, if p(n) has been specified, or adds partitions if p(n) is new partition letter.

Example: Define three partitions on an RMD. The first occupies ten tracks and uses protection code Q, the second two tracks and code S, and the third 48 tracks without protection.

```
PRT,A,10,Q,B,2,S,C,060,*
```

18.3.2 FRM (Format Rotating Memory) Directive

This directive causes RAZI to run a bad-track analysis on the specified RMD and build a new PST for it or accepts a previously constructed bad-track-table from the RMD and builds a new PST for it.* The directive has the general form

FRM,lu,size,flag

where

lu is the logical-unit name or number to which the subject RMD is assigned. This must be the assigned to the first partition.

size is the number (octal or decimal) of tracks on the RMD

flag is 1 to perform a complete bad-track analysis, or 0 to accept a bad-track-table from the RMD

*FRM clears all PSTs and directories. It should not be used when a unit contains a good BIT and files as these will be destroyed.

Caution: When performing a bad-track analysis or accepting a bad-track table from an RMD the bad-track table is positioned adjacent to the resident foreground task area. Unless there already exists an active bad-track table for the prior RMD, the bad-track table for the new RMD will be overlayed, if the resident foreground area is increased by means of a partial SYSGEN. Thus if a partial SYSGEN is performed which increases the resident foreground size, another RAZI must be performed.

Examples: Clear the RMD assigned to PO, having 203 tracks, and build a PST for it according to previously defined partition information.

```
FRM,PO,203,0
```

Run a complete bad-track analysis on the RMD assigned to 25, having 128 tracks, and build a PST for it according to previously defined partition information.

```
FRM,25,128,1
```

620-35 and 620-34 discs in a system require the formatting program (describe in section 18.4) to format disc and analyze bad tracks.

18.3.3 INL (Initialize) Directive

This directive causes RAZI to incorporate a PST and a bad-track table from the named RMD into the VORTEX nucleus. It has the general form

INL,lu,size

where **lu** and **size** have the same definition as in the FRM directive (section 18.3.2).

Example: Read the PST and bad-track table from the unit assigned to BO, having 128 tracks, and incorporate them into the VORTEX nucleus.

```
INL,BO,128
```

18.3.4 EXIT Directive

This directive terminates RAZI. It has the general form

EXIT

Example: Terminate RAZI.

```
EXIT
```

18.4 70-7500 (620-35) DISC PACK FORMATTING PROGRAM

Each 70-7500 (620-35) disc pack requiries formatting before any input or output operation can be performed on it. Before VORTEX can be prepared on a 70-7500 disc pack or any 70-7500 discs can be used under VORTEX, disc packs must be formatted. The formatting program forms 120-word sectors, which are grouped 24 per track. The program also examines the disc pack for bad tracks.

The formatting program operates in a stand-alone mode. It may be loaded and executed with either AID or BLD. Execution begins at location 01354. Upon execution the formatting program requests some parameters to be input from the keyboard. The following requests are made. An inappropriate response causes the request to be repeated.

Request

INPUT BTC NUMBER

Type a value and a carriage return. The acceptable values are octal 020, 022, 024, 026 and 070

INPUT DEVICE ADDRESS

Type a value in the range from octal 014 through 017 followed by a carriage return

INPUT VARIABLE SECTOR GAP

Type a value and carriage return. Acceptable values are 1, 2, 3, 4, 6, 8, 12, or their equivalent octal representations. This value determines the physical location on the disc pack of sequentially addressable sectors, as such sequential transfers may be accomplished without waiting for a full revolution of the disc unit. Recommended setting is 3. Another setting may be more effective depending upon various application parameters such as number of tasks, frequency of disc transfers, and types of disc transfers.

INPUT UNIT NUMBER

Type unit number followed by a carriage return. Acceptable values are 0 through 3. Up to four units can be connected to a single controller.

In addition the formatting program performs bad-track analysis and creates and maintains a bad-track table, which is entered on each disc pack at the completion of its formatting. The bad-track table is located on sectors 0 through 2 of the first track. The table is 254 words long, starting at word 64 of sector 0. The first 64 words of sector 0 reserve the necessary space for the PST. The remaining unused words of sector 2 are filled with zeroes. Each disc I/O error will generate a ten-event retry sequence, which upon failure will set the bad-track flag within the track header. The program also sets the corresponding bit in the bad-track table. No alternate tracks are assigned.

If the first track is determined to be bad, the bad-track table may not be placed there. The program prints the error message,

```
FIRST TRACK BAD
```

and aborts formatting the current disc pack. The program returns to the keyboard interrogation routine. After the bad-track table has been written on the disc pack, the formatting program resumes the keyboard interrogation to obtain parameters for formatting the next disc. In this way, more than one disc pack can be formatted in the same session. The formatting program may be terminated at this point when no disc packs (except those with bad first tracks) remain unformatted. If an unsafe condition (SELECT LOCK light on) occurs, reload and execute the program. Formatting disc packs is not necessary before every VORTEX system generation. Head crashes generally indicate formatting should be done again.

18.5 70-7510 (620-34) DISC PACK FORMATTING PROGRAM

Each 620-34 disc pack requires formatting before any input or output operation can be performed on it. Before VORTEX can be prepared on a 620-34 disc pack or these disc can be used under VORTEX, the packs must be formatted. The formatting program forms 120-word sectors, which are grouped 24 per track. The program also examines the disc pack for bad tracks.

The formatting program operates without an operating system. It may be loaded and executed either with AID II or BLD II. Its execution begins at location 01354. Upon execution the formatting program requests some parameters to be input from the keyboard. An inappropriate response causes the request to be repeated. The following requests are made.

INPUT BTC NUMBER

Type a value and a carriage return. The acceptable values are octal 020, 022, 024, 026 and 070.

INPUT DEVICE ADDRESS

Type a value in the range from octal 014 through 017 followed by a carriage return.

INPUT VARIABLE SECTOR GAP

Type a value and a carriage return. Acceptable values are 1, 2, 3, 4, 6, 8, 12, or their equivalent octal representations. This value determines the physical location on the disc pack of sequentially addressable sectors, as such sequential transfers may be accomplished without waiting for a full revolution of the disc unit. Recommended setting is 3. Another setting may be more effective depending upon various application parameters such as number of tasks, frequency of disc transfers, and types of disc transfers.

INPUT UNIT NUMBER

Type unit number followed by a carriage return. Acceptable values are 0 through 3. Up to four units can be connected to a single controller.

In addition the formatting program performs bad-track analysis and creates and maintains a bad-track table, which is entered on each disc pack at the completion of its formatting. The bad-track table is located on sectors 0 through 4 of the first track. The table is 508 words long, starting at word 64 of sector 0. The first 64 words of sector 0 reserve the necessary space for the PST. The remaining unused words of sector 4 are filled with zeros. Each disc I/O error will generate a ten-event retry sequence, which upon failure will set the bad-track flag within the track header. The program also sets the corresponding bit in the bad-track table. No alternate tracks are assigned.

If the first track is determined to be bad, the bad-track table may not be placed there. The program prints the error message:

```
FIRST TRACK BAD
```

and aborts formatting the current disc pack. The program returns to the keyboard interrogation routine. After the bad-track table has been written on the disc pack, the formatting program resumes the keyboard interrogation to obtain parameters for formatting the next disc. In this way, more than one disc pack can be formatted in the same session. The formatting program may be terminated at this point when no disc packs (except those with bad first tracks) remain unformatted. If an unsafe condition (SELECT LOCK light on) occurs, reload and execute the program. Formatting disc packs is not necessary before every VORTEX system generation. Head crashes generally indicate formatting should be done again.

18.6 70-7603/7613 DISC PACK FORMATTING PROGRAM

Each 70-7613/7613 disc pack requires formatting before any input or output operation can be performed on it. The formatter forms 120 word sectors which are grouped 48 per track. The program also performs a bad-track analysis.

The formatter (format F p/n 92A0205-030) operates under the MAINTAIN III executive. For instructions on loading from magnetic tape, cards or paper tape, see the MAINTAIN III Manual (98A9952-070). Execution begins at location 500. Some parameters are requested from the keyboard. Inappropriate responses cause the request to be repeated. All inputs are terminated by periods.

```
INPUT BIC NUMBER
```

Enter an even value in the range octal 020 through 076.

```
INPUT DEVICE ADDRESS
```

Enter a value in the range octal 014 through 017.

```
INPUT UNIT
```

Enter a value in the range 0 through 7. This must be the physical unit number calculated as follows:

UUP$_{(2)}$

where

UU is unit number 0-3
P is platter 0 fixed
platter 1 removable
(Note: System RMD is always 000 regardless of which platter.

```
INPUT KNOWN BAD TRACKS
```

Enter octal track numbers in the range 0 through 0625 separated by commas and terminated by a period. If there are no known bad tracks, input only a period.

In addition, the formatting program performs bad-track analysis and creates and maintains a bad-track table, which is entered on each disc pack at the completion of its formatting. The bad-track table is located on sector 0 of the first track. The table is 26 words long, starting at word 64 of sector 0. The first 64 words of sector 0 reserve the necessary space for the PST. The remaining unused words of sector 0 are filled with zeros. Each disc I/O error will generate a five event retry sequence which, upon failure, will set the corresponding bit in the bad-track table. No alternate tracks are assigned.

If the first track is determined to be bad, the bad-track table may not be placed there. The program prints the error message,

```
        FIRST TRACK BAD
```

and aborts formatting the current disc pack. The program returns to the keyboard interrogation routine. After the bad-track table has been written on the disc pack, the formatting program resumes the keyboard interrogation to obtain parameters for formatting the next disc. In this way, more than one disc pack can be formatted in the same session. The for- matting program may be terminated at this point when no disc packs (except those with bad first tracks) remain unformatted. Formatting disc packs is not necessary before every VORTEX system generation. Head crashes generally indicate formatting should be done again

18.7 WRITABLE CONTROL STORE (WCS)

The writable control store must be loaded with the appropriate firmware. The WCS is loaded by the V73 WCS Microprogram Utility (MIUTIL). MIUTIL is a foreground program scheduled by a request:

```
        ;SCHED,MIUTIL,p,FL,F
```

where p is the priority level. Use of the MIUTIL program is described in detail in the Microprogramming Guide.

If the optional V70 series Floating Point Firmware is to be used, it must be loaded into page 1 of WCS. The WCS microprogram is catalogued into the OM library under the name WCSFP, and must be transferred to the BI device for loading by MIUTIL. The WCS should be initialized through the use of MIUTIL prior to loading the floating-point microprograms.

Section 20 gives additional information about writable control store.

SECTION 20
WRITABLE CONTROL STORE AND FLOATING-POINT PROCESSOR

The **Writable Control Store (WCS)** option extends the Varian 70 series processor's read-only control store to permit the addition of new instructions, development of microdiagnostics, and optimal tailoring of the computer system to its application. Unlike the read-only control store, which contains the Varian 70 series standard instruction set and cannot be altered, the WCS can be loaded from main memory under control of certain I/O instructions. The capabilities of WCS give the user more complete access to the resources of the Varian 70 series computer system.

20.1 MICROPROGRAMMING SOFTWARE

Supporting software for the WCS includes the following:

- Microprogram assembler MIDAS
- Microprogram simulator MICSIM microprogram
- Microprogram utility loader and diagnostic MIUTIL
- WCS reload task

All software for microprogram development operates under VORTEX. The capabilities and use of WCS and its supporting software are described in the Varian Microprogramming Guide.

20.1.1 Microprogram Assembler

The Varian microprogram simulator (MICSIM) helps the programmer to verify and optimize microprograms. MICSIM runs the output from MIDAS within the system's main memory. At selected times, conditions and the contents of data locations can be examined and changed. MICSIM is scheduled from the background library at level 0 by

Under VORTEX, MIDAS is scheduled from the background library at level 0 by

```
/LOAD,MIDAS
```

20.1.2 Microprogram Simulator

The Varian microprogram simulator (MICSIM) helps the programmer to verify and optimize microprograms MICSIM runs the output from MIDAS within the system's main memory. At selected times, conditions and the contents of data locations can be examined and changed. MICSIM is scheduled from the background library at level 0 by

```
/LOAD,MICSIM
```

20.1.3 Microprogram Utility

Loading the control store with the assembled and tested microcode is performed by microprogram utility, MIUTIL

In addition, on-line debugging directives are available through the utility on a special configuration. The MIUTIL program operates as a foreground program at priority level set by the user. The program is scheduled by operator input over the OC device. For example,

```
;SCHED,MIUTIL,3,FL,F
```

The microprogram utility is also responsible for maintaining an up-to-date image of the contents of the WCS on an RMD file, named WCSIMG on the OM library, see section 15.8. This image is then used by the WCS reload task, WCSRLD, to restore the WCS following a power failure/restart and VORTEX reload. The RMD file image is updated each time the R directive is used to exit from the utility.

If the update is completed successfully, the message

```
WCS SAVED
```

is output on the OC and LO devices before the utility exits. If the RMD file for saving the WCS is not present on the OM library the OM library, the system outputs

```
IO10,MIUTIL
FILE WCSIMG NOT FOUND
WCS SAVE ABORTED
```

I/O errors which may occur during the save operation result in outputting messages

```
IOxx,MIUTIL
WCS SAVE ABORTED
```

If the restoration of WCS is completed successfully, the message WCS RELOADED will be output to the OC and LO devices before the reload task exits.

To exit from the microprogram utility without updating the RMD file, the operator may issue the directive.

```
;ABORT,MIUTIL
```

20.1.4 WCS Reload Task, WCSRLD

This task, WCSRLD, reinitializes the WCS to the contents specified by the RMD file image of WCS, WCSIMG on the OM library. It is automatically scheduled on power failure/restart or upon the reloading of the VORTEX system. In this way, WCS contents are preserved through any periods without power.

Though usually scheduled automatically by the system, the reload task may also be scheduled manually by the operator. For example, the following directive schedules the reload task at priority level 15:

```
        ;SCHED,WCSRLD,15,FL,F
```

20.2 STANDARD FIRMWARE

Standard firmware is available on the 70 series computers to provide faster and more compact code. The executable code which uses the firmware, or microprograms, is automatically generated by the VORTEX FORTRAN IV compiler when the option F is specified (in the JCP directive /FORT, see section 4.2.15). The firmware also extends the capabilities of the user's assembly language programs and the support library (see section 13).

Standard firmware includes routines which are loaded into the system's WCS for the following categories of operations:

- Arithmetic for two-word fixed-point and integer numbers
- Arithmetic for real (floating-point) numbers
- Transfer of two word values, such as a memory to memory move
- FORTRAN oriented routines
- Byte manipulation
- Stack manipulation

Executing a branch-to-control-store (BCS) instruction causes a transfer of control from the system's read-only memory to the WCS at the address specified in the BCS instruction. The MIUTIL program (see section 20.1.3) loads the standard firmware as well as any extensions to the instruction set the user may write. To execute firmware, the program must use a BCS instruction with the appropriate entry address and calling sequence for passing parameters.

A FORTRAN IV program specifies the option F on its request for compilation, and then BCS instructions are generated. The FORTRAN IV programs use this firmware without any changes to the FORTRAN IV statements.

Due to size constraints, some firmware is unavailable under certain hardware configurations. Table 20-1 shows these restrictions.

Table 20-1. Firmware Availability

	Hardware Configurations	
Firmware Routine	**without FPP**	**with FPP**
XAD,XSB	YES	YES
XMU,XDV	YES	NO
IMU,IDV	NO	YES
FAD,FSB,FMU,FDV	YES	NO
FSQ	NO	YES
FLD,FST,FMV	YES	YES
FSE,FDO,FDO1	YES	YES
FTNE,FTEQ,...,FTGT	NO	YES
FJNE,FJEQ,...,FJGT	NO	YES
FAIF,FIOP	NO	YES
FRSC,FRSR,FJAG	NO	YES
Byte Firmware	YES	YES
Stack Firmware	YES	YES

20.2.1 Fixed-Point Arithmetic Firmware

Two-word fixed-point and integer numbers use the following arithmetic firmware:

Mnemonic	Function	BCS Call
XAD	Fixed-point and integer add	0105334
XSB	Fixed-point and integer subtract	0105374
XMU	Fixed-point multiply	0105274
XDV	Fixed-point divide	0105234
IMU	Integer multiply	0105027
IDV	Integer divide	0105067

These operations are performed on the hardware A and B registers (AB), using the number specified by the second word of the respective BCS call. If overflow occurs, AB is set to the maximum number with the proper sign and the overflow flag (OVFL) is set.

For two-word fixed-point numbers, the decimal point is assumed to be to the left of bit 15 of the most significant word. For two-word integer numbers, the decimal point is assumed to be to the right of bit 0 of the least significant word. As a result, rounding and overflow conditions are different for multiply and divide. For example, multiplying two double-word numbers produces a logical four-word result. The fixed-point function returns the high order two-words and drops the lower two. The integer multiply returns the lower two-words of the logical result and sets overflow if either of the two higher words are non-zero.

20.2.2 Floating-Point Arithmetic Firmware

The addition, subtraction, multiplication, and division of single-precision real, or floating-point, numbers can be performed with the following firmware.

Mnemonic	Function	BCS Call
FAD	Floating-point add	0105134
FSB	Floating-point subtract	0105174
FMU	Floating-point multiply	0105074
FDV	Floating-point divide	0105034
FSQ	Floating-point square root	0105127

A floating-point arithmetic operation is performed on AB using the floating-point number specified by the second word of the BCS call. If underflow occurs, AB is set to zero. If overflow occurs, AB is set to the maximum floating-point number with a proper sign. Taking square root of a negative number results in the overflow being set and AB set to zero.

20.2.3 Data Transfer Firmware

The data transfer firmware routines load AB from memory, store AB in memory, and move the contents of two contiguous memory locations to another place in memory.

Mnemonic	Function	BCS Call
FLD	Load AB with two words from memory	0105032
FST	Store AB into memory	0105033
FMV	Memory-to-memory move of two words	0105037

20.2.4 FORTRAN-Oriented Firmware

These microprograms are oriented toward FORTRAN IV operations. However, they have a similar utility to assembly-language programs.

Mnemonic	Use	BCS Call
FINE	Test for not equal	0105024
FTEQ	Test for equal	0105064
FTLT	Test for less than	0105124
FTGE	Test for greater than or equal	0105164
FTLE	Test for less than or equal	0105324
FTGT	Test for greater than	0105364
FJNE	Jump if not equal	0105026
FJEQ	Jump if equal	0105066
FJLT	Jump if less than	0105126
FJGE	Jump if greater than or equal	0105166
FJLE	Jump if less than or equal	0105326
FJGT	Jump if greater than	0105366
FAIF	Arithmetic IF processor	0105226
FIOP	Indexed operand processor	0105167
FRSC	Reentrant subroutine call	0105025
FRSR	Reentrant subroutine return	0105065
FJAG	Jump if A register greater	0105125
FSE	Pass parameters between subroutines	0105036
FDO	Terminate DO loop	0105035
FDO1	Terminate DO loop (1 increment)	0105027

For FSE, the calling routine would use the following sequence:

```
        CALL    SUB
        DATA    P1         Address of first
        •                data to be moved
        •
        DATA    Pn         Address of last
                           data to be moved
```

In the subroutine being called, the following sequence is necessary to receive the data or data address:

```
SUB     BSS     1
        DATA    0105036    BCS transfer for FSE
        DATA    n          Number of parameters
        BSS     m          Number of parameters
```

The second instruction, FDO to control a DO loop, uses the following calling sequence:

```
        DATA    0105035    BCS transfer to FDO
        DATA    P1         Address of DO
                           increment

        DATA    P2         Address of DO loop
                           counter

        DATA    P3         Address of DO loop
                           limit

        DATA    P4         Address for jump if
                           the counter is not
                           greater than the
                           limit
```

The third instruction, FDO1 to control a DO loop with increment of 1 uses the following calling sequence.

DATA	0105027	BCS transfer to FDO1
DATA	P1	Address of DO loop counter
DATA	P2	Address of DO loop limit
DATA	P3	Address for jump if the counter is not greater than the limit

The DO loop is incremented and tested against the DO loop limit. If the loop counter is less than the limit, execution continues at the address specified by the BCS call word 5. If the value of the loop counter is equal to or greater than the value represented by the limit, execution continues at the instruction following this calling sequence.

The calling sequence for all the relational test (FT--) and jump (FJ--) instructions are as follows:

BCS	
DATA	Address of first number
DATA	Address of second number
DATA	Jump address

These routines compare the two single precision floating-point numbers pointed to be the words following the BCS. The A register is set to minus one or zero, depending on the specified relation being met or not met, respectively. For the jump instructions, FJ--, the branch address is taken only when the condition is met, (i.e., when the A register equals minus one). Note that the specified relation is that of the first number to the second. For example, FTGT tests for the first number greater than the second.

The calling sequence for the arithmetic IF processor (FAIF), is as follows:

BCS	
DATA	Address of first number
DATA	Address of second number
DATA	Branch address if less than
DATA	Branch address if equal
DATA	Branch address if greater than

This BCS also compares two single precision floating-point numbers. It determines if the first number is less than, equal to, or greater than the second number, and then takes the appropriate branch address.

The indexed operand processor is used to compute the effective address of an element in a FORTRAN real array. It has the following call sequence:

BCS	
DATA	Address of index value
DATA	Base address

The effective address is computed by subtracting one from the index value, multiplying the result by two, and then adding in the base address. This allows for an array with two-word entries and induces from one to 'n'. The effective address is stored in the second word of the following instruction.

The reentrant subroutine call, FRSC, has the following call sequence:

BCS	
DATA	Subroutine address

The B register points to a memory location which is used as a stack pointer. This memory location is decremented and the resulting value used as the address where the return address is stored.

Control is then transferred to the subroutine. Note that the subroutine address should be that of the first instruction of the subroutine.

The reentrant subroutine return, FRSR, has a calling sequence consisting of just the BCS without parameters. The return address is popped off the stack using the B register and the memory stack pointer as in the subroutine call. Note that no limit checks are made on the stack by either the call or the return. Also, the stack pointer format is not consistent with that of the general stack firmware.

The BCS calling sequence for FJAG (jump if A register greater than zero) is as follows:

BCS	
DATA	Jump address

The jump address is taken only if the A register is strictly greater than (and not equal to) zero.

20.2.5 Byte Manipulation Firmware

The byte instructions use a byte pointer address where bits 15-1 specify the word number and bit 0 is 0 for the left byte and 1 for the right byte. The byte-oriented instructions implemented in firmware are:

Mnemonic	Function	BCS Call
CBS	Compare byte strings	0105030
MBS	Move byte string	0105070

In the first microprogram sequence, the CBS instruction requires that the second word contain the address to which control is returned if the strings are not equal. The B register contains the byte starting address of the first string, the X register is the byte starting address of the second string, and the A register specifies the number of bytes to be compared.

The second byte-oriented microprogram sequence, the MBS instruction, moves the number of bytes specified in the A register from the location specified by the B register to the location specified by the X register.

Both share a common BCS entry point, and this may be extended for six more instructions.

20.2.6 Stack Firmware

A stack is kept in memory for use for return addresses, temporary storage or arithmetic operations. The base and limit of the stack (see figure 20-1) are defined by the user. The stack control block is indicated by a pointer in the second word of the calling sequence. Figure 20-2 is the format of the stack control block.

The following BCS instructions correspond with each of the stack operations:

Operation	BCS	Operation	BCS
Add	0105031	Push	0105231
Subtract	0105071	Pop	0105331
Multiply	0105131	Push double	0105271
Divide	0105171	Pop double	0105371

Eight stack instructions transfer to the same initial entry point in the WCS, where the decoder determines the specific instruction to be executed.

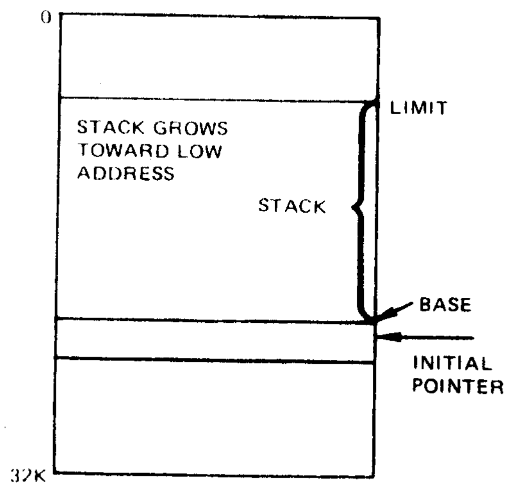


Figure 20-1. Base and Limit of Stack

On all stack operations, if the top-of-stack pointer (PTR) ever exceeds the boundaries of the stack (as the user defined them in the stack control block), no further processing takes place and a JMPM is made to the fourth word in the stack control block.

Single-Precision Integer Stack Arithmetic

Add: adds the top two words of the stack, increments the pointer and replaces the new topmost word. If the result exceeds the maximum positive number (077777), the overflow indicator (OF) and the sign in bit 15 are set to one. For example, adding 000002 to 077777 sets OF to one and the result to 100001.

Subtract: subtracts the next stack word from the top of stack word (by adding the top word to the two's complement of the next stack word), increments the top-of-stack pointer, and stores the remainder in the new top-of-stack word. If the result exceeds the maximum negative number, it sets the overflow indicator and resets the sign.

Multiply: multiplies the two words at the top of the stack and replaces them by their 32-bit product (see figure 20-3). The most significant part of the product is placed in the top word, and the least significant portion will be placed in the next word. The sign bit of the top word gives the sign of the product, and the sign of the next word is set to zero. The overflow indicator (OF) is not set.

Word	
0	CURRENT STACK POINTER
1	LIMIT OF STACK
2	BASE OF STACK
3	ADDRESS OF INSTRUCTION WHICH CAUSED STACK OVERFLOW OR UNDERFLOW
4	ERROR ROUTINE FOR OVERFLOW OR UNDERFLOW

Figure 20-2. Stack Control Block

Divide: divides the top stack word into the following two words. The top-of-stack pointer (PTR) is incremented and the single-precision quotient with the sign of the dividend is stored in the new top-of-stack location. The remainder is stored in the next stack location (see figure 20.4).

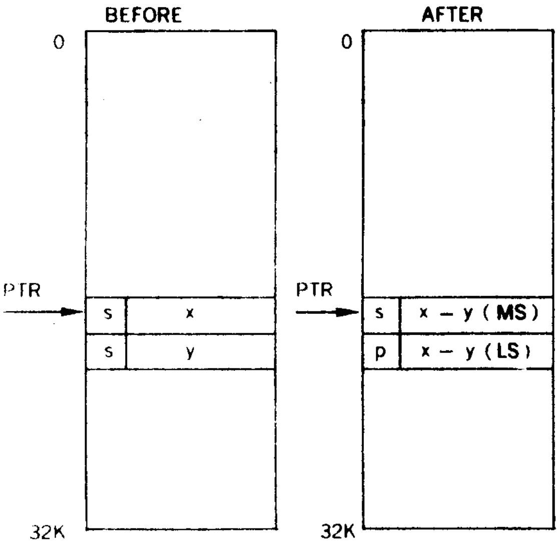
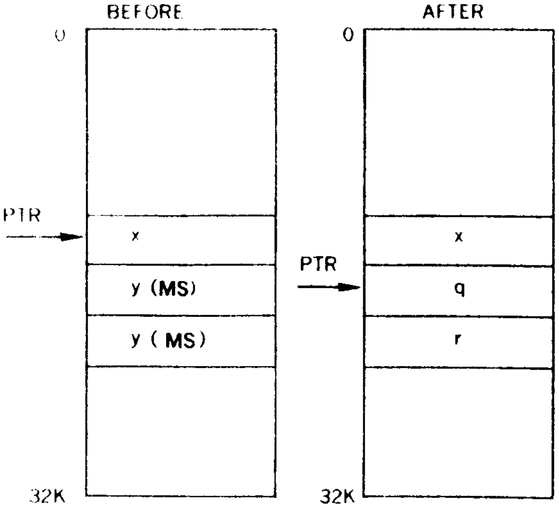


Figure 20-3. Stack Multiply

If the quotient overflows, the contents are unpredictable, and control is returned with the overflow indicator set (OF).



+ y/± x = ± quotient q with remainder r

Figure 20-4. Stack Divide

Stack operators: these operators also require a stack control block as in figure 20-2.

Push (SPUSH): the A register (R0) is placed on the stack at the location addressed by the decremented top-of-stack pointer (see figure 20-5.)

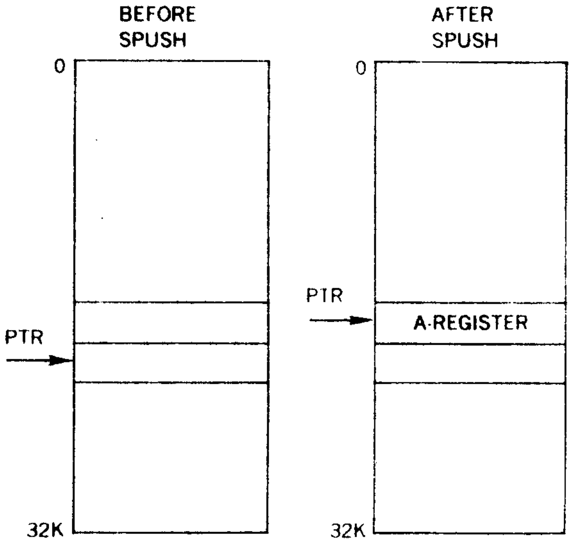


Figure 20-5. Stack Push

Pop (SPOP): the A-register (R0) is loaded from the top stack word and the stack pointer is incremented (see figure 20-6).

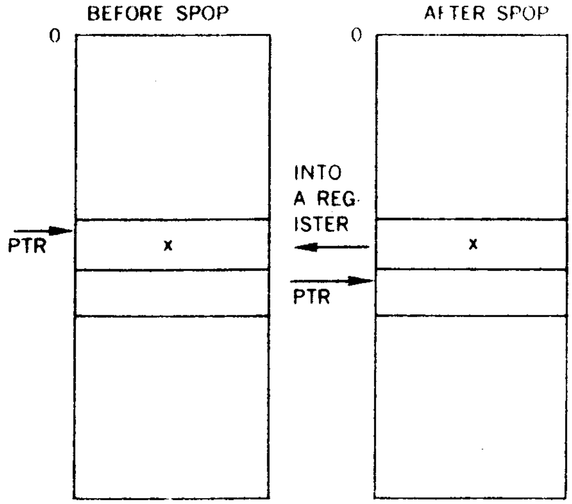


Figure 20-6. Stack Pop

Push Double (PUSHD): decrements the stack pointer and stores the B register (R1), and then decrements the pointer and stores the A register (R0) (see figure 20-7).

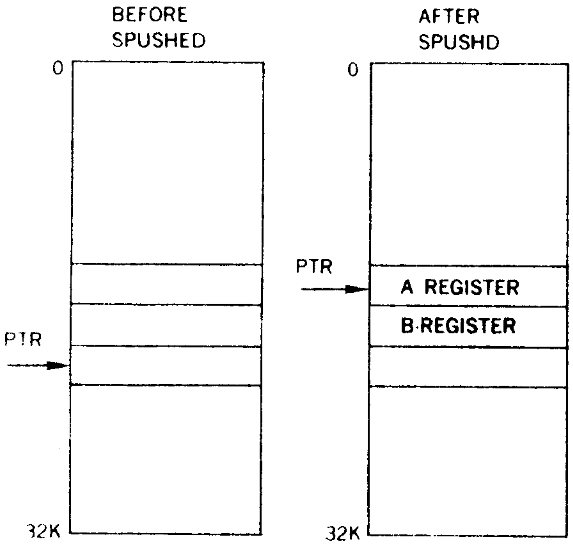


Figure 20-7. Stack Double Push

Pop Double (POPD): loads the A register (R0) with the word addressed by the top-of-stack pointer and then increments the top-of-stack pointer; loads the B register (R1) with the word addressed by the new value of the top-of-stack register and then increments the top-of-stack pointer again (see figure 20-8).

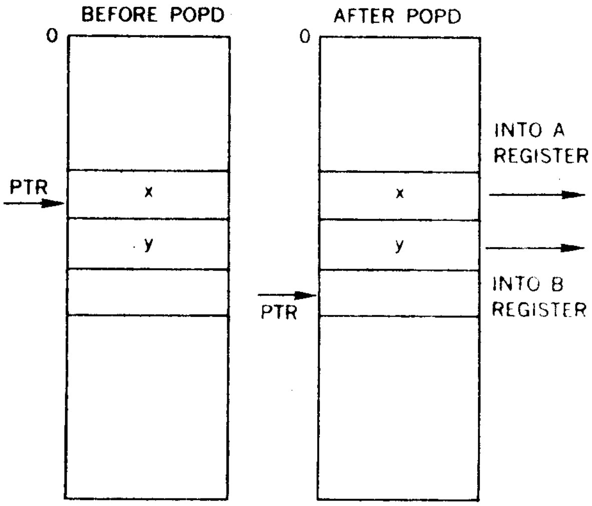


Figure 20-8. Stack Double Pop

20.2.7 Firmware Macros

The mnemonics given are not supported by the DAS MR assembler. The assembly-language programmer must supply his own macros in order to use any of these mnemonics. The following are examples and possible use of the required macros.

Macro **Use**

Fixed point add:

```
XAD     MAC                                   XAD     address
        DATA     0105334,P(1)
        EMAC
```

Fixed point subtract:

```
XSB     MAC                                   XSB     address
        DATA     0105374,P(1)
        EMAC
```

Fixed point multiply.

```
XMU     MAC                                   XMU     address
        DATA     0105274,P(1)
        EMAC
```

Fixed point divide:

```
XDV     MAC                                   XDV     address
        DATA     0105234,P(1)
        EMAC
```

Integer multiply:

```
IMU     MAC                                   IMU     address
        DATA     0105027,P(1)
        EMAC
```

Integer divide:

```
IDV     MAC                                   IDV     address
        DATA     0105067,P(1)
        EMAC
```

and, immediately following the macros for floating point divide, add:

Floating square root:

```
FSQ     MAC                                   FSQ     address
        DATA    0105127,P(1)
        EMAC
```

Floating point add:

```
FAD     MAC                                   FAD     address
        DATA     0105134,P(1)
        EMAC
```

Floating point subtract:

```
FSB      MAC                                    FSB      address
         DATA     0105174,P(1)
         EMAC
```

Floating point multiply:

```
FMU      MAC                                    FMU      address
         DATA     0105074,P(1)
         EMAC
```

Floating point divide:

```
FDV      MAC                                    FDV      address
         DATA     0105034,P(1)
         EMAC
```

Load AB:

```
FLD      MAC                                    FLD      address
         DATA     0105032,P(1)
         EMAC
```

Store AB:

```
FST      MAC                                    FST      address
         DATA     0105033,P(1)
         EMAC
```

Memory to memory:

```
FMV      MAC                                    FMV      address,address
         DATA     0105037,P(1),P(1)
         EMAC
```

Pass parameters:

```
FSE      MAC                                    FSE      #params
         DATA     0105036,P(1)
         BSS      P(1)
         EMAC
```

DO loop:

```
FDO      MAC                                    FDO       inc addr, count addr,
                                                          lim addr, loop addr
         DATA    0105035,P(1),P(2),
                 P(3),P(4)
         EMAC
```

DO loop (one increment):

```
FDO1     MAC                                    FDO1      count addr, lim addr,
                                                          loop addr
         DATA    0105027,P(1),P(2),P(3)
         EMAC
```

Test for not equal:

```
FTNE     MAC                                FTNE     OP address, OP address
         DATA     0105024,P(1),P(2)
         EMAC
```

(Typical relational test form).

Jump if not equal:

```
FJNE     DATA     0105026,P(1),P(2),P(3)   FJNE     OP address, OP address
                                                    jump address
```

(Typical relational Jump form).

Arithmetic IF processor:

```
FAIF     MAC                                FAIF     OP address, OP address,
         DATA     0105226,P(1),P(2),P(3),P(4),P(5)LT address, EQ address,
         EMAC                                        GT address
```

Index operand processor:

```
FIOP     MAC                                FIOP     index address, base
         DATA     0105167,P(1),P(2)                  address
         EMAC
```

Reentrant subroutine call:

```
FRSC     MAC                                FRSC     sub address
         DATA     0105025,P(1)
         EMAC
```

Reentrant subroutine return:

```
FRSR     MAC                                FRSR
         DATA     0105065
         EMAC
```

Jump if A register greater:

```
FJAG     MAC                                FJAG     jump address
         DATA     0105125,P(1)
         EMAC
```

Compare string:

```
CBS      MAC                                CBS       non compare addr
         DATA    0105030,P(1)
         EMAC
```

Move string.

```
MBS      MAC                                MBS
         DATA    0105070
         EMAC
```

Stack add:

```
SADD    MAC                                 SADD     stack addr
        DATA    0105031,P(1)
        EMAC
```

Stack subtract:

```
SSUB    MAC                                 SSUB     stack addr
        DATA    0105071,P(1)
        EMAC
```

Stack multiply:

```
SMUL    MAC                                 SMUL     stack addr
        DATA    0105131,P(1)
        EMAC
```

Stack divide:

```
SDIV    MAC                                 SDIV     stack addr
        DATA    0105171,P(1)
        EMAC
```

Stack push:

```
SPUSH   MAC                                 SPUSH    stack addr
        DATA    0105231,P(1)
        EMAC
```

Stack pop:

```
SPOP    MAC                                 SPOP     stack addr
        DATA    0105331,P(1)
        EMAC
```

Stack push double:

```
SPUSHD  MAC                                 SPUSHD   stack addr
        DATA    0105271,P(1)
        EMAC
```

Stack pop double:

```
SPOPD   MAC                                 SPOPD    stack addr
        DATA    0105371,P(1)
        EMAC
```

The Floating Point Processor has the following OP codes.

Mnemonic	Opcode	Operation
FLD	0105420	Floating load single
FLDD	0105522	Floating load double
FAD	0105410	Floating add single
FADD	0105503	Floating add double
FSB	0105450	Floating subtract single
FSBD	0105543	Floating subtract double
FMU	0105416	Floating multiply single
FMUD	0105506	Floating multiply double
FDV	0105401	Floating divide single
FDVD	0105535	Floating divide double
FLT	0105425	Fix to float
FIX	0105621	Float to fix
FST	0105600	Floating store single
FSTD	0105710	Floating store double

Load or Float interrupts are locked out until a store or fix. EX34, -- as time out.

An interrupt after a store may change floating-point registers. User should restore their contents.

Mnemonics for floating-point operations are not supported by DAS MR. The following are possible macros which must be included by the user to define the mnemonics:

```
        Macro                                        Use

FLD     MAC                                          FLD     address
        DATA     0105420,P(1)
        EMAC

FLDD    MAC                                          FLDD    address
        DATA     0105522,P(1)
        EMAC

FAD     MAC                                          FAD     address
        DATA     0105410,P(1)
        EMAC

FADD    MAC                                          FADD    address
        DATA     0105503,P(1)
        EMAC

FSB     MAC                                          FSB     address
        DATA     0105450,P(1)
        EMAC

FSBD    MAC                                          FSBD    address
        DATA     0105543,P(1)
        EMAC

FMU     MAC                                          FMU     address
        DATA     0105416,P(1)
        EMAC
```

```
FMUD    MAC                             FMUD     address
        DATA    0105506,P(1)
        EMAC

FDV     MAC                             FDV      address
        DATA    0105401,P(1)
        EMAC

FDVD    MAC                             FDVD     address
        DATA    0105535,P(1)
        EMAC

FLT     MAC                             FLT      address
        DATA    0105425,P(1)
        EMAC

FIX     MAC                             FIX      address
        DATA    0105621,P(1)
        EMAC

FST     MAC                             FST      address
        DATA    0105600,P(1)
        EMAC

FSTD    MAC                             FSTD     address
        DATA    0105710,P(1)
        EMAC
```

20.2.8 Commercial Firmware

Commercial firmware is available on the 70 series computers for supporting VORTEX, COBOL, and TOTAL. The firmware and assembly language routine V$DECM (see section 13), also extends the capabilities of the user's assembly language programs.

Commercial firmware includes the following operations:

- COBOL decode
- Load/Store multiple registers
- Main storage move or compare
- 32 bit unsigned math

Additionally, an assembly language routine V$DECM is provided in the support library for interface to the firmware decimal math routines.

The Commercial Firmware package is optionally available with the FORTRAN accelerator package requiring 1024 words of WCS on a V70 series computer.

COBOL Decode

COBOL decode uses the most significant 5 bits of the specified word of main storage to perform a 32 way branch. Register R2(X) points to the main storage word to be decoded. The BCS is followed by the 32 vector addresses. When the BCS is complete, R0(A) contains 0 and R1(B) contains the least significant eleven bits (left justified). R2 is not incremented. The calling routine uses the following sequence:

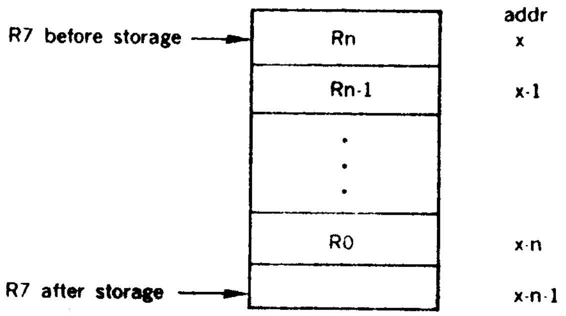
```
DATA          0105021                    BCS value
DATA          vector address zero
DATA          vector address one
         .
         .
         .
DATA          vector address thirty-one
```

Load/Store Registers

Multiple register loading or storing is performed by the following BCS instructions:

			Registers loaded/stored
DATA	0105020	load	R0
	0105060		R0,R1
	0105120		R0,....,R2
	0105160		R0,....,R3
	0105220		R0,....,R4
	0105260		R0,....,R5
	0105320		R0,....,R6
	0105360	load	R0,....,R7
DATA	0105017	store	R0
	0105057		R0,R1
	0105117		R0,....,R2
	0105157		R0,....,R3
	0105217		R0,....,R4
	0105257		R0,....,R5
	0105317		R0,....,R6
	0105357	store	R0,....,R7

R7 contains the main storage address for loading or storing registers. Register contents are stored in main storage as follows:



R7 is decremented to the location following the contents of R0. For load registers, R7 initially points to the word following R0. After loading is complete, R7 will point to the last register loaded.

Main Storage Move or Compare

The Move routine moves a byte block of main storage from one area to another (overlap is allowed). The compare routine compares two byte blocks of main storage. The compare is logical and sets a user supplied condition word as follows:

0 = first block less than second block
1 = first block equal to second block
2 = first block greater than second block

At the end of each byte move or compare, byte pointers are incremented. Optionally, the user may specify non-incrementing of the first block byte pointer. This will result in storing a single byte value throughout a block of main storage or comparing a single byte value to a block of main storage.

Initially R0(A) points to the user's descriptive parameter block and R1(B) contains the address of the user's condition word. The parameter block appears as follows:

word	0	byte addr of first main storage block
	1	byte addr of second main storage block
	2	number of bytes for move or compare

The calling routine will issue one of the following BCS values:

0105223	Move without increment
0105263	Compare with increment
0105323	Compare without increment
0105363	Compare with increment

When execution is complete, parameter block contents are as follows:

Move without increment

word 0 = single byte address
word 1 = last byte stored address + 1
word 2 = 0

Move with increment

word 0 = last byte fetched address
word 1 = last byte stored address + 1
word 2 = 0

Compare without increment

word 0 = single byte address
word 1 = last byte compared address + 1 if equal
= last byte compared address if unequal
word 2 = 0 if equal. Otherwise decremented once for each equal byte.

Compare with increment

word 0 = last byte compared address
word 1 = last byte compared address + 1 if equal.
= last byte compared address if unequal.
word 2 = 0 if equal. Otherwise decremented once for each equal byte.

32 Bit Integer Math

These routines perform the operations add, subtract, multiply, and divide on 32 bit unsigned integer operands. Register R0(A) contains the four word parameter block address. The four word parameter block contains the two operands and received the results as follows:

add Operand two is replaced by the sum of the two operands.

subtract Operand two is replaced by operand one minus operand two.

multiply Both operands are replaced by the 4 word product of the two operands.

divide Operand one receives the quotient of operand one divided by operand two; operand two is replaced by the remainder.

The hardware overflow flag is set when any of the following occur:

- carry out of the most significant bit during an add.
- subtracting a larger number from a smaller one.
- dividing by zero.

SECTION 21
FILE MAINTENANCE UTILITY

The File Maintenance Utility program (FMUTIL) is a background task for copying and/or loading files, file directories and/or partitions from one device onto another, for manipulating files and records, for formatting files and records which are to be displayed or printed, and for managing filename directories and space allocations of the files.

Only files assigned to rotating memory devices (disc or drum) can be referenced by name.

File space is allocated contiguously within a partition, skipping bad tracks.

21.1 ORGANIZATION

FMUTIL is scheduled for execution by inputting the JCP directive /FMUTIL. If the SI logical unit is a teletype or a CRT device, the message FU** is output to indicate that the SI unit is waiting for FMUTIL input. Once activated, FMUTIL accepts directives from the SI unit until:

a. Another JCP directive (first character is a slash) is input, or

b. The exit directive, E, is input.

In either case, FMUTIL terminates and JCP is scheduled.

If there is an error, one of the error messages given in appendix A is output on the SO logical unit, and a record is input from the SO unit to the JCP buffer. If the first character of this record is /, FMUTIL exits via the EXIT request. If the first character is C, FMUTIL continues. If the first character is neither / or C, the record is processed as a normal FMUTIL directive.

21.2 PARTITION SPECIFICATION TABLE

For a description of the Partition Specification Table (PST) and File Name Directory, refer to section 9.1.

21.3 OUTPUT LISTINGS

FMUTIL outputs the following two types of listings to the LO logical unit:

a. Directive Listing lists, without modification, all FMUTIL directives entered from SI logical unit.

b. Directory Listing, lists file names from a logical unit filename directory in response to the FMUTIL,P,D, and L directives.

All FMUTIL listings begin with the standard VORTEX headings.

21.4 FILE MAINTENANCE UTILITY DIRECTIVES

The following file maintenance utility functions are supported by FMUTIL:

D Dumps RMD files, partitions, and file name directories to magnetic tape.

L Loads RMD files, partitions, and file name directories from magnetic tape.

R Rewinds magnetic tape

E Writes end-of-file on magnetic tape.

S Searches for RMD files, partitions, and file name directories on magnetic tape.

P Prints a listing of file names contained on each directory.

U Releases all unused space in each file.

E Exits from FMUTIL.

File maintenance utility directives comprise sequences of character strings having no embedded blanks. The characters strings are separated by commas (,) or key equal signs (=). Although not required, a period (.) is a line terminator. Comments can be inserted after the period.

The general form of a file maintenance utility directive is

directive, *p(1),1(2),...,p(n)*

where

directive is one of the directive names given above.

p(1) is a parameter

Numerical data can be octal or decimal. Each octal number has a leading zero.

For greater clarity in the descriptions of the directives, optional blank separators between character strings, and the optional replacement of commas (,) by equal signs (=) are omitted.

Error messages applicable to file maintenance utility directives are given in appendix A.

21.5 D DIRECTIVE

This directive dumps information contained in files, partitions, and/or directories onto magnetic tape where this information can be later re-loaded onto the RMD, or stored for later use. There are three types of D directives; one for file, one for partitions, and one for directories.

21.5.1 Dump File

The directive for dumping a file has the following general form

D,lun,*key*,file,tapelun

where

lun is the number of name of the input logical unit.

key is the partition protection code.

file is the name of the file being dumped.

tapelun is the number or name of the output logical unit. (magnetic tape only)

When a file is dumped to magnetic tape, it is organized with a header record, end-of-file, n file records, and terminates with a double end-of-file. The file, after the dump with the header record, is formatted as follows:

Each n file record has 5,760 words, except for the last which has the remaining number of words in the file. In other words, the last record may have less than 5,760 words.

On a dump file directive a listing is output. The listing output format is as follows:

```
        PAGE XXXX XX/XX/XX XX:XX:XX VORTEX  FMTLCK   FMUTIL

D,22,X,COBINT,18
COBINT           141          0        141
```

The top heading line consists of:

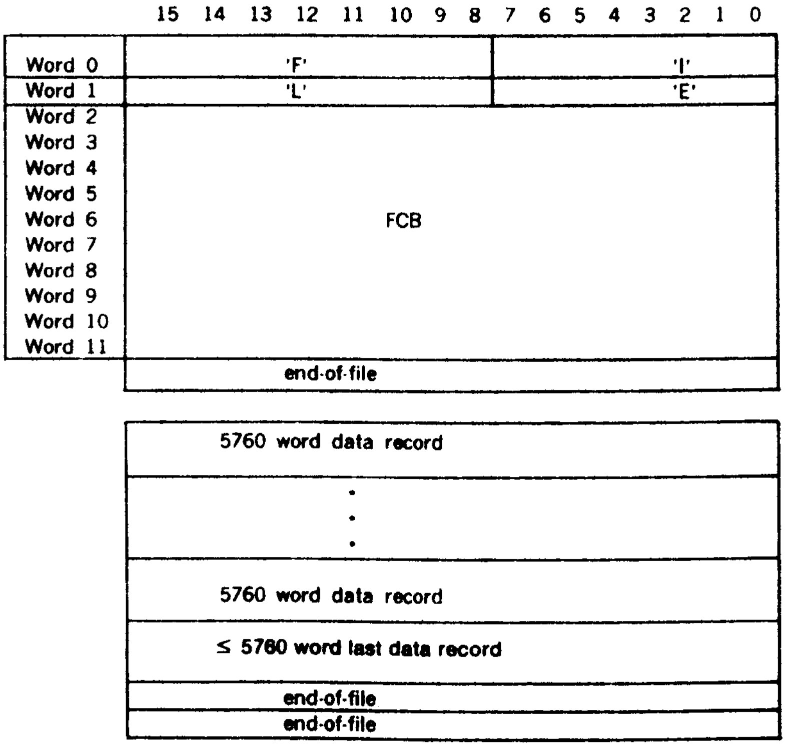
a. One blank

b. The word PAGE

c. Four character positions that contain the decimal page number

d. Two blanks

e. Eight character positions that contain the current data obtained from the VORTEX resident constant V$DATE.



f. Two blanks

g. Eight character positions that contain the current time HR: MN: SC.

h. Two blanks

i. Name of run-time operating system.

j. Two blanks

k. The / JOB name of which the system is executing

l. Two blanks

m. Eight character positions that contain the job processor name, FMUTIL

n. Blanks through the 120th character position.

Beginning with the first character position, the next line (after 2 blank lines) contains the list of the input directives.

Beginning with the first character position the next line contains: the name of the file, number of sectors used, number of sectors unused, and the number of total sectors allocated to the file.

Example: Dump the file COBINT contained on logical unit 22, whose protection code is X, onto magnetic tape unit 18.

```
D,22,X,COBINT,18
```

21.5.2 Dump Partition

The directive for dumping a partition has the following general form

D,lun,*key*,ALL,tapelun

where

lun is the number or name of the input logical unit.

key is the protection code required to address lun.

tapelun is the output logical unit (magnetic tape only).

ALL keyword specifying partition dump.

All partitions dumped onto magnetic tape are organized with a header record, n files record, and terminated by an end-of-file.

The header record is formatted as follows:

Bit	15 14 13 12 11 10 9 8	7 6 5 4 3 2 1 0
Word 0	'P'	'A'
Word 1	'R'	'T'
Word 2	number of file entries	
Word 3	logical unit number	
Word 4	all zeros	
Word 5		
Word 6		
Word 7		
	end-of-file	

An alternate name record has the format shown below:

Bit	15 14 13 12 11 10 9 8	7 6 5 4 3 2 1 0
Word 0	'E'	'N'
Word 1	'T'	'R'
Word 2 Word 3 Word 4	Entry Name	
Word 5 Word 6 Word 7	Original Name	
Word 8	file size	
	end-of-file	

A partition dump directive produces a listing. This listing output format has the following FMUTIL heading, a one line heading as shown below:

```
FILENAME USED UNUSED TOTAL LOGICAL UNIT-XXXX
```

The heading line consists of:

a. One blank

b. The word FILENAME that shows an alphabetical list of all the file located on a particular partition.

c. Four blanks

d. The word USED shows many sectors, of each file, contain information.

e. Four blanks

f. The word UNUSED shows how many sectors contain blanks.

g. Five blanks

h. The word TOTAL shows the total number of sectors allocated to each file.

i. Forty spaces

j. The words LOGICAL UNIT shows what logical unit the files are located on.

k. Four character positions that contain the logical unit number.

Example: Dump the partition contained on logical unit OM, protection code D, onto magnetic tape unit 18.

```
D,OM,D,AL,18
```

21.5.3 Dump File-Name Directory

The directive for dumping a directory has the following general form

D,lun,key,DIR,tapelun

where

lun	is the number or name of the input logical unit.
key	is the protection code required to address lun.
tapelun	is the number or name of the output logical unit. (magnetic tape only.)
DIR	keyword specifying directory dump.

A filename directory dumped to magnetic tape is organized into a header record, directory record, and double end-of-file. The header record is formatted as follows:

Bit	15 14 13 12 11 10 9 8	7 6 5 4 3 2 1 0
Word 0	'D'	'I'
Word 1	'R'	blank
Word 2	all zeros	
Word 3	logical unit number	
Word 4	all zeros	
Word 5		
Word 6		
Word 7		
	end-of-file	

The directory record has the following format:

Bit	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Word 0	Directory Sector Addr
1-120	120 word directory block
121	Directory Sector Addr
122-241	120 word directory block
	• • •
5639	Directory Sector Addr
5640 5759	120 word directory block
	end-of-file
	end-of-file

Example: Dump directories for partition contained on logical unit OM, protection code D, onto magnetic tape unit 18.

```
D,OM,D,DIR,18
```

21.6 L DIRECTIVE

This directive loads information into RMD files, partitions, and/or directives from magnetic tape.

There are three types of L directives, one for files, one for partitions, and one for directories.

21.6.1 Load File

The directive for loading a file has the following general form

L,lun,*key*,file,tapelun

where

lun is the number or name of the output logical unit.

key is the partition protection code.

file is the name of the file being loaded.

tapelun is the number or name of the input magnetic tape unit.

When a file is being loaded from magnetic tape, a search is made for that file. After the search, the tape is positioned in front of the file within the correct partition dump. The search stops if a double end-of-file is encountered and an error message is output. After the file is located, an attempt is made to create the file space. If the file already exists the existing file is used. If the existing file is too small, an error message is output.

When creating a file for loading, the file size of the created file will include all of the original extent of the file, including the unused portion.

When a file already exits, the only check made is to see if there is enough space for the used portion of the file as on the tape, and the original extent of the file is ignored.

On a load file directive a listing is output. The listing output format is the same as the D directive when files are called. The only change would be the directive shown on the listing.

Example: Load the file COBINT contained on magnetic tape unit 18 onto RMD logical unit 22, protection code is X.

```
L,22,X,COBINT,18
```

21.6.2 Load Partition

The directive for loading a partition has the following general form

L,lun,*key*,ALL, tapelun

where

lun is the number or name of the output logical unit.

key is the partition protection code.

tapelun is the number or name of the input magnetic tape unit.

ALL keyword specifying partition load.

When a partition is loaded, from magnetic tape, a search is made for it as specified by the logical unit number parameter. After the search tape is positioned in front of the required partition dump, the search stops if a triple end-of-file is encountered and an error message is output.

When the partition is found, the files are loaded as indicated key file loading in the order in which they appear on the tape. If any non-previous record names are encountered, an entry is made in the directory for them.

During the loading of a partition, space for the directory is allocated at the beginning of the partition. After loading, however, there is no embedded unused space in the partition. All unused space is at the end of the partition.

On a partition load directive, a listing is output. The listing output has the following FMUTIL heading, a one-line heading as shown below:

```
FILENAME USED UNUSED TOTAL START END LOGICAL UNIT-XXXX
```

The heading line consists of:

a. One blank

b. The word FILENAME that gives a list of all filenames now contained in the partition.

c. Four blanks

d. The word USED shows how many sectors per filename contain valid information.

e. Four blanks

f. The word UNUSED shows how many sectors per filename contain blanks.

g. Five blanks

h. The word TOTAL shows how many sectors have been allocated to each file.

i. Ten blanks

j. The word START shows the beginning sector number

k. Seven blanks

l. The word END shows the ending sector numbers.

m. Fifteen blanks

n. The word LOGICAL UNIT shows on which logical unit (partition) these files are contained.

o. Four character positions that contain the logical unit number.

Example: Load the partition contained on magnetic tape, which is on logical unit 18, onto RMD logical unit name OM, protection code.

```
L,OM,D,ALL,18
```

21.6.3 Load Directory

The directive for loading filename directories has the following general form

L,lun,*key*,DIR,tapelun

where

lun is the number or name of the output logical unit.

key is the protection code required to address lun.

tapelun is the number or name of the input magnetic tape unit.

DIR keyword specifying directory load.

When a directory is being loaded, a search is made for it on the input magnetic tape, after the search tape is positioned in front of the required partition directory.

If the directory is found its sectors are loaded onto their former recorded sectors. No reorganization takes place.

If the directory is not found or if a triple end-of-file is encountered, an error message is output, and the search stops.

Example: Load directory for partition contained on magnetic tape, on magnetic tape unit 18, onto RMD logical unit OM, protection code is D.

```
L,OM,D,DIR,18
```

21.7 R DIRECTIVE

This directive rewinds a magnetic tape to the beginning of tape. The directive has the general form

R,lun

where

lun is the number or name of the input or output magnetic tape unit.

Example: Rewind magnetic tape located on logical unit 18.

```
R,18
```

21.8 E. DIRECTIVE

This directive writes an end-of-file on a magnetic tape. The directive has the general form

E,lun

where

lun is the number or name of the output magnetic tape unit.

This directive should be used after writing a series of files onto magnetic tape instance:

|Header Record | EOF | Series of Partition Files | EOF | EOF | EOF *|

*The E directive is used to write the third end-of-file.

```
E,18
```

21.9 S DIRECTIVE

This directive searches for files, partitions, and directories located on magnetic tapes. The directive has the general form

S,lun,*key*,tapelun

where

lun	is the number or name of the RMD's logical unit.
key	is the protection code required for addressing lun.
tapelun	is the number or name of the input magnetic tape unit.

After the search, the tape will be positioned after the partition or file identification record, and is now ready for the loading of individual files.

Example: Search for the partition, file or directory named OM, protection code D, located on logical unit 18.

```
S,OM,D,18
```

21.10 P DIRECTIVE

This directive prints out a listing of the file directory on the LO for each partition specified. The directive has the general form

P,lun,*key*

where

lun	is the number or name of the input logical unit.
key	is the protection code required for addressing lun.

Files are listed in alphabetical order. The output listing has, following the FMUTIL heading, a one-line heading as shown below:

```
FILENAME USED UNUSED TOTAL START END LOGICAL UNIT-XXXX
```

The heading line consists of:

a. One blank

b. The word FILENAME that gives a list of all filenames contained in a partition.

c. Four blanks

d. The word USED shows how many sectors per filename contain information.

e. Four blanks

f. The word UNUSED shows how many sectors per filename contain blanks

g. Five blanks

h. The woro ıOTAL shows how many sectors have been allocated for each file.

i. Ten blanks

j. The word START shows the beginning sector number.

k. Seven blanks

l. The word END shows the ending sector number.

m. Fifteen blanks

n. The words LOGICAL UNIT, one character, a dash (-), shows upon which logical unit (partition) these files are contained.

o. Four character positions that contain the logical unit number.

Example: Print a listing of OM, protection code D.

```
P,OM,D
```

21.11 U DIRECTIVE

This directive releases unused space from files, after they have been written on the RMD. The directive has the general form

U,lun,*key*,file

where

lun	is the number or name of the logical unit where space to be released is located in the protection code
key	is the protection code required for addressing lun.
file	is the name of the file where the unused space is located.

Example: Release unused space located in file COBINT, on partition 22, protection code X.

```
U,22,X,COBINT
```

21.12 EXIT DIRECTIVE

This directive exits from FMUTIL. The directive has the general form

```
E
```

where

E	keyword specifying EXIT from FMUTIL

Example: Exit from FMUTIL

```
E
```

APPENDIX A
ERROR MESSAGES

This appendix comprises a directory of VORTEX operating system error messages, arranged by VORTEX component. For easy reference, the number of the subsection containing the error messages for a component ends with a number corresponding to that of the section that covers the component itself, e.g., the file-maintenance error messages are listed in subsection A.9 because the file-maintenance component itself is discussed in section 9.

A.1 ERROR MESSAGE INDEX

Except for the language processors (section 5), VORTEX error messages each begin with two letters that indicate the corresponding component:

Messages beginning with:	Are from component:	Listed in subsections:
CM	Concordance program	A.5.3
DG	Debugging program	A.7
DP	Dataplot II	A.12
EX	Real time executive	A.2
FM	File maintenance	A.9
IO	I/O control	A.3
IU	I/O utility	A.10
JC	Job-control processor	A.4
LG	Load-module generator	A.6
MS	Microprogram simulator	A.20.2
MU	Microprogram utility	A.20.3
NC	VTAM Network control	A.21
OC	Operator communication	A.17
RP	RPG IV Compiler	A.3
RT	RPG IV Runtime/Loader	A.5.3
SE	Source editor	A.8
SG	System generator	A.15
SM	System maintenance	A.16
ST	VSORT	A.11
*	DAS MR assembler	A.5.1

Section A.24 gives explanations of error codes listed under "Possible User Action" in the last column of the following sections.

A.2 REAL-TIME EXECUTIVE

Message	Condition	Action	Possible User Action
EX01,xxxxxx	Invalid RTE service request by task xxxxxx	Abort task xxxxxx	D01,D02,P01
EX02,xxxxxx	Scheduled task xxxxxx name not in specified load-module library	Abort task xxxxxx	D01,D03
EX03,xxxxxx	Task xxxxxx made RESUME request but requested task not found	Continue scheduling task	D01,D03
EX04,xxxxxx	Task xxxxxx made ABORT request but requested task not found	Task xxxxxx continues	D01,D03
EX05,xxxxxx	Background task xxxxxx larger than allocatable	Task xxxxxx not loaded	M01,M02,M03 M04,P02
EX06,xxxxxx	Not enough allocatable space available for ALOC request	Abort task xxxxxx	M06
EX07,xxxxxx	OVLAY requests a segment not in library	Abort task xxxxxx	D01,D03

EX10,xxxxxx	Scheduled request has a library task priority conflict (task priority 0 from foreground library, task priority 2 from background library). Scheduled request specifies a foreground task to be executed at priority 0 or 1	Schedule request ignored, scheduling task continues	D04,D02,P01
EX11,xxxxxx,n	Memory protection violation at address n	Abort task xxxxxx	P03
EX12,xxxxxx	I/O link error (foreground task making request, or incorrect logical unit number)	Abort task xxxxxx	P01
EX13,xxxxxx	Attempted to load map registers and a sense-DMA-error stop condition occurred	Abort task xxxxxx	H05
EX14,xxxxxx	Lack allocable TIDB memory space for task xxxxxx attempted to be scheduled	If an OPCOM request, OPCOM is aborted. If the schedule is not an OPCOM, the request is reattempted	M02
EX15,xxxxxx	Foreground common specified by background task	Abort task xxxxxx	P01
EX16,xxxxxx	PASS macro specified zero or negative word count	Abort task xxxxxx	P01
EX17,xxxxxx	RMD I/O error detected when SAL attempted to load scheduled task, xxxxxx. Also pseudo TIDB data assumed bad, execution address less than 01000	Abort task xxxxxx	H06,P01
EX20,xxxxxx,h	Map memory-protection HALT violation at virtual address n in task xxxxxx	Abort task xxxxxx	P17

Note: **xxxxxx** is the name of a task

EX21,xxxxxx,n	Map memory-protection I/O violation at virtual address n in task xxxxxx. User attempted to execute I/O command in a map other than map 0	Abort task xxxxxx	P17
EX22,xxxxxx,n	Map memory-protection WRITE violation at virtual address n in task xxxxxx. User attempted to write/ store into read-only or read-operand-only location	Abort task xxxxxx	P17
EX23,xxxxxx,n,m	Map memory-protection JUMP violation at virtual address n in task xxxxxx. User attempted to jump into read-operand-only location m + 2	Abort task xxxxxx	P17
EX24,xxxxxx,n,m	Map memory-protection UNASSIGNED violation at virtual address n in task xxxxxx. User attempted to read or write into unassigned location m	Abort task xxxxxx	P17
EX25,xxxxxx,n	Map memory-protection instruction-fetch violation at virtual address n in task xxxxxx. User attempted to fetch an instruction from read-operand-only location	Abort task xxxxxx	
EX26,xxxxxx,m	Firmware floating point or stack overflow or underflow occurred at logical address or in task xxxxxx.	Task is continued at location n+2	None
EX27,xxxxxx	ALOCPG request error. Parameter error or pages not available for allocation.	Program continues execution at specified reject address	P01

EX30,xxxxxx	DEALPG request error. Parameter error. Program continues execution at specified reject address	Program continues execution at specified reject address	P01
EX31,xxxxxx	MAPIN request error. Request executed by priority 0 task	Program continues execu at specified reject address	P01
EX32,xxxxxx	Attempted to schedule a task from a non-RMD unit	Directive ignored	D02,P01
EX33,xxxxxx	Floating-point processor, FPP, error	Program continues at the address following the FPP store instruction	None
EX34,xxxxxx	Floating-point processor, FPP, timeout	Program continues at interrupted instruction	None

[1] The instruction which generated the memory-protection violation and the contents of the A, B, and X (and V75) registers are also posted.

Note: **xxxxxx** is the name of a task.

A.3 I/O CONTROL

Message	**Condition**	**Action**	**Possible User Action**
I000,xxxxxx	Unit not ready, or unit file protected	Repeats message until condition is corrected	H01,H03
I001,xxxxxx	Device declared down	Repeats message until condition is corrected	H04,D19
I002,xxxxxx	Invalid LUN specified	Abort task or request	D02,P01

IO03,xxxxxx	FCB/DCB parameter error	Abort task or request	P04
IO04,xxxxxx	Invalid protection code	Abort task or request	D01,D02,P01
IO05,xxxxxx	Protected partition specified by unprotected task	Abort task or request	P01
IO06,xxxxxx	I/O request error, e.g., I/O-complete bit not set, prior request may be queued	Abort task or request	P01
IO07,xxxxxx	Attempt to read from a write-only device, or vice versa	Abort task or request	D02,P01
IO10,xxxxxx	File name specified in OPEN or CLOSE not found	Abort task or request	D01,D03,P01, D29
IO11,xxxxxx	Invalid file extent, record number, address or skip parameter, file already closed	Abort task or request	P04,P01
IO12,xxxxxx	RMD OPEN/CLOSE error, or bad directory thread, seek or read error on OPEN request.	Abort task or request	H05,D03
IO13,xxxxxx	Level 0 program read a JCP (/) directive	Task xxxxxx is aborted, directive passed to JCP buffer	None
IO14,xxxxxx	Interrupt timed out or no cylinder-search complete interrupt	Abort task or request	H05,D05
IO15,xxxxxx	Disc cylinder-search or malfunction error	Abort task or request	H05
IO16,xxxxxx	Disc read/write timing error	Abort task or request	H05
IO17,xxxxxx	Disc end-of-track error	Abort task or request	H05
IO20,xxxx	BIC: abnormal stop, not ready, or time out error on device xxxx	Abort task or request	D05,H05
IO30,xxxxxx	Parity error	Abort task or request	H05,D02

1031,xxxxxx	Reader or tape error	Abort task or request	H05,P19
1032,xxxxxx	Odd-length record error	Abort task or request	H05,P12
1033,xxxxxx	Invalid terminal identifier or logical line number	Request ignored	D27
1034,xxxxxx	Line or terminal not opened	Request ignored	D28
1035,xxxxxx	Line or terminal down	Request ignored	D28
1036,xxxxxx	Line or terminal already open	Request ignored	D28
1037,xxxxxx	Request still pending	Request ignored	None
1040,xxxxxx	Action on terminal not opened	Request ignored	D28
1042,xxxxxx	Invalid physical line address	Request ignored	D27
1043,xxxxxx	Invalid TCM type	Request ignored	D27
1044,xxxxxx	No temporary storage available	Request ignored	None
1045,xxxxxx	RMD error. Format, end-of-file or head selection error	Abort task or request	H05,D13
1046,xxxxxx	Map memory protection I/O data transfer error	Abort task or request	H05
1047,xxxxxx	User write specified word count > 73	Record is **truncated**	P04
105x,xxxxxx	RMD read error on spool stream X. Specified stream is last digit of error number	The data is used	H06
1060,xxxxxx	RMD file full	The program waits until space is available on the file. The message is repeated every 200 times the condition occurs	D08

IO61,xxxxxx	User parameter error in request	Request is ignored	P01
IO62,xxxxxx	RMD write error	The bad sector is skipped. This is likely to cause an IO5x error later, but no data will be lost	H06
IO63,xxxxxx	Buffer unavailable for spooler	Spooler waits until buffer is available	None

Note: xxxxxx is the name of a task or device.

A.4 JOB-CONTROL PROCESSOR

Message	**Condition**	**Action**	**Possible User Action**
JC01	Invalid JCP directive	Ignore directive	D01,D02
JC02	Invalid or missing parameter in a JCP directive; or illegal separator or terminator	Ignore directive	D01,D02
JC03	Specified physical device cannot perform the functions of the assigned logical unit	Ignore directive	D07,H06
JC04	Invalid protection code or file name in a JCP directive	Ignore directive	D01,D02
JC05,nn	End of tape before the number of files specified by an /SFILE directive has been skipped; or end of tape, beginning of tape, or file mark before the number of records specfied by an /SREC directive has been skipped where nn is the number of files (or records) remaining to be skipped	SFILE, SREC terminates upon error condition	P07

JC06	An irrecoverable I/O error while compiling or assembling; or an error during a load/go operation; or insufficent symbol table memory (insufficient /MEM directive), or an EOF was encountered before an END statement	Job flushed to next /JOB directive	P07,M01,P06
JC07	Invalid or illegal logical/physical-unit referenced in JCP directive	Ignore directive	D01,D02,H06

A.5 LANGUAGE PROCESSORS

A.5.1 DAS MR Assembler

During assembly, the source statements are checked for syntax errors and usage. In addition, errors can occur where the program cannot determine the correct meaning of the source statement.

When an error is detected, the assembler outputs an error code following the source statement containing the error, on the LO unit, and continues to the next statement.

The assembler error messages are:

Message	Condition
*IL	First nonblank character of the source statement invalid (statement is not processed)
*OP	Instruction field undefined (two no-operation (NOP) instructions are generated in the object module)
*SY	Expression contains undefined symbol
*EX	Expression contains two consecutive arithmetic operators
*AD	Address expression error
*FA	Floating-point number format error
*DC	An 8 or 9 in an octal constant
*DD	Invalid redefinition of a symbol or the location counter
*VF	Instruction contains variable subfields either missing or inconsistent with the instruction type
*MA	Inconsistent use of indexing and indirect addressing three symbolic source statements to be assembled

***NS**	Nested DUP statements
***NR**	Symbol table full
***TF**	Tag error (undefined or illegal index register specifications)
***SZ**	Expression value too large for the size of the subfield, or a DUP statement specifying more than
***UD**	Undefined digit in an arithmetic expression
***SE**	The symbol in the label field has, during pass 2, a value different than that in pass 1
***E**	Syntax error (source statement incorrectly formed)
***R**	Relocation error (relocatable item encountered where an absolute item was expected)
***MQ**	Missing right quotation mark in character string
***=**	Invalid use of literal
***II**	Implicit indirect reference when I parameter is present on the /DASMR directive

A.5.2 FORTRAN IV Compiler and Runtime Compiler

During compilation, source statements are checked for such items as validity, syntax, and usage. When an error is detected, it is posted on the LO usually beneath the source statement. The errors marked T terminate binary output.

All error messages are of the form

```
ERR xx c(1)-c(16)
```

where xx is a number form 0 to 18 (notification error), or T followed by a number from 0 to 9 (terminating error); and c(1)-c(16) is the last character string (up to 16) encountered in the statement being processed. The right-most character indicates the point of error and the @ indicates the end of the statement. The possible error messages are:

Notification Error	**Definition**
0	Illegal character input
1	Construction error
2	Usage error
3	Mode error
4	Illegal DO termination
5	Improper statement number
6	Common base lowered
7	Illegal equivalence group
8	Reference to nonexecutable statement
9	No path to this statement
10	Multiply defined statement number
11	Invalid format construction
12	Spelling error
13	Format statement with no statement number
14	Function not used as variable
15	Truncated value
16	Statement out of order
17	More than 29 named common regions
18	Noncommon data
19	Illegal name
20	DO index not referenced
21	Name is dummy
22	Array name previously declared
23	Exponent underflow or overflow
24	Undefined statement number

Terminating Error	Definition
T0	I/O error
T1	Construction error
T2	Usage error
T3	Data pool overflow
T4	Illegal statement
T5	Improper use
T6	Improper statement number
T7	Mode error
T8	Constant too large
T9	Improper DO nesting
T10	DO not parenthesized
T11	Item not operand
T12	Item not function
T13	Invalid unary +,
T14	Invalid hierarchy
T15	Invalid =
T16	Illegal operator
T17	Function statement without parameters
T18	Logical If follows logical If
T19	Invalid dimensions
T20	Operand is not a name
T21	Too many numeric characters
T22	Non-numeric exponent
T23	Terminator not
T24	Illegal terminator
T25	Not statement end
T26	Invalid common type
T27	Target statement precedes DO
T28	Subscript variable not dummy
T29	Not first statement (Title statement)
T30	First two characters not DO
T31	Not in subprogram
T32	Subscript not integer constant

Note: due to optimization, the error message may appear on the next labeled statement and not on the actual statement error.

RUNTIME

When an error is detected during runtime execution of a program, a message is posted on the LO device of the form:

taskname message

Fatal errors cause the job to be aborted; execution continues for non-fatal errors. The messages and their definitions are:

Message	Cause
ARITH OVFL	Arithmetic overflow
GO TO RANGE	Computed GO TO out of range*
FUNC ARG	Invalid function argument (e.g., square root of negative number)
FORMAT	Error in FORMAT statement*
MODE	Mode error (e.g., outputting real array with I format)*
DATA	Invalid input data (e.g., inputting a real number from external medium with I format)*
I/O	I/O error (e.g., parity, EOF)*

* indicates fatal error; all others non-fatal

A.5.3 RPG IV Compiler and Runtime Compiler

During compilation, source statements are checked for such items as validity, syntax and usage. When an error is detected an arrow is printed pointing to the discrepancy in the source statement and an error message is output on the LO device. Detailed descriptions can be found in the RPG IV User's Manual (98 A 9947 03X). The possible error messages are:

Messages

Indicator
Invalid
Label
Literal
Name
Relational
Size
Syntax

If an I/O error occurs during compilation one of the following messages is posted on Logical Unit 15 and compilation is terminated:

Message	Condition	Action	Possible User Action
RP01,nnn	I/O error	Compilation terminated	H06
RP02,nnn	End of file error	Compilation terminated	P07
RP03,nnn	End of device error	Compilation terminated	P07
RP04	End card error (End card encountered before procedure card)	Compilation terminated	P07
RP05	Available memory exceeded	Compilation terminated	M01,M03,M04

where nnn is the logical unit number on which the error occurred.

RPG Runtime/loader during the loading or executing of an RPG IV object program in the background any of the following conditions will cause an error. The message is posted on Logical Unit 15 and the task aborted:

Message	Condition	Action	Possible User Action
RT01,nnn	I/O error	Task aborted	H06
RT02,nnn	End of file error	Task aborted	P07
RT03,nnn	End of device error	Task aborted	P07
RT04	Program too big	Task aborted	P07
RT05	Invalid object record	Task aborted	P08
RT06	Checksum error	Task aborted	P08
RT07	Sequence error	Task aborted	P08
RT08	Program not executable	Task aborted	P08
RT09	Work list overflow	Task aborted	M01,M02 M03 M04
RT10,xxxxxx	Invalid call to subroutine or missing subroutine where xxxxxx = subroutine name	Task aborted	P08

Concordance Program:

Message	Condition	Action	Possible User Action
CN01	Symbol table full	Partial concordance output, then next segment is processed	M01

A.6 LOAD-MODULE GENERATOR

Message	Condition	Action	Possible User Action
LG01	Invalid LMGEN directive	Ignore directive	D01,D02
LG02	Invalid or missing parameter in an LGMEN directive	Ignore directive	D01,D02
LG03	Check-sum error in object module	Abort loading	P08,D02
LG04	READ error in object module	Abort loading	P08,H06
LG05	WRITE error in load module loading	Abort loading	P08,H06
LG06	Cataloging error, name already in library, library full	Abort loading	D03,H06
LG07	Loader code error in object module	Abort loading	P08
LG08	Sequence error in object module	Abort loading	P08
LG09	Structure error in object module (i.e., non-binary record)	Abort loading	P08
LG10	Literal pool overflow or use of literal or indirect by foreground program	Abort loading	P08,P09
LG11	Invalid redefinition of common-block size during load-module generation	Abort loading	P08
LG12	Load-module size exceeds available memory or SW file size	Abort loading	P02,D34

LG13	LMGE internal tables exceed available memory	Abort loading	M01
LG14	Number of overlay segments input not equal to that specified in TIDB	Abort loading	D01,D02
LG15	Undefined externals	Loading continues	P10
LG16	No program execution address	Loading continues. Address defaults to the first location of the program	P17
LG17	Attempt to load protected task on background library or unprotected task on foreground library	Abort loading	D01,D02,D33
LG18	No load module to catalog	Abort cataloging	P08

A.7 DEBUGGING PROGRAM

			Possible
			User
Message	**Condition**	**Action**	**Action**
DG01	Invalid DEBUG directive	Ignore directive	D01,D02
DG02	Invalid or undefined parameter in DEBUG directive	Ignore directive	D01,D02

A.8 SOURCE EDITOR

			Possible
			User
Message	**Condition**	**Action**	**Action**
SE01	Invalid SEDIT directive	Directive ignored	D01,D02
SE02	Invalid or missing parameter in SEDIT directive	Directive ignored	D01,D02
SE03	Error reported by IOC call	Edit terminated	H06
SE04	Invalid end of file	Edit terminated	P07

A.9 FILE MAINTENANCE

Message	Condition	Action	Possible User Action
FM01	Invalid FMAIN directive	Ignore directive	D01,D02
FM02	Name already in directory	Module not added	D03,D01,D02, D07
FM03	Name not in directory	Module not deleted	D03,D01,D02
FM04	Insufficient space for entry	Module not added	D07,D08,D09
FM05	I/O error	FMAIN process terminated	H06
FM06	Directory structure error, including writing over the directory by direct addressing of an RMD partition	FMAIN process terminated	H06
FM07	Check-sum error in object module	FMAIN process terminated	P08
FM08	No entry name in object module	FMAIN process terminated	P08
FM09	Record-size error in object module	FMAIN process terminated	P12
FM10	Loader code error in object module	FMAIN process terminated	P08
FM11	Sequence error in object module	FMAIN process terminated	P08
FM12	Non-binary record in object module	FMAIN process terminated	P12
FM13	Number of input logical unit not specified by INPUT	FMAIN process terminated	D01,D02
FM14	Insufficient space in memory	FMAIN process terminated	M01

* Messages **FM07** through **FM14** apply only to the processing of object modules. The occurrence of any of these errors requires that the processing of the object module be restarted after the error condition is removed.

A.10 I/O UTILITY

Message	Condition	Action	Possible User Action
IU01	Invalid IOUTIL directive	Directive ignored	D01,D02
IU02	Invalid or missing parameter in IOUTIL directive	Directive ignored	D01,D02
IU03	PFILE directive not used to open an RMD file	Directive ignored	D02
IU04	I/O error	IOUTIL process terminated	H06
IU05,nn	END-OF-FILE before the specified number or records skipped. When nn = the number of records remaining when the END-OF-FILE or END-OF-DEVICE (on RMD only) occurred. END-OF-TAPE outputs MSG where operator has option to ;RESUME or ABORT. Note: nn is module 0 to 100.	SFILE, SREC terminates upon error condition	P07

A.11 SORT ERROR MESSAGES

Message	Condition	Action	
ST01,xxxxxxxx	Invalid or missing parameter or control word for the SORT control word xxxxxxxx	Abort job	D01
ST02	Record lengths for INPUT and OUTPUT unequal and no user exit specified.	Abort job	D01
ST03	SORT control field ending character position is less than start character position, or character position is past end of sort record	Abort job	D01
ST04	Insufficient memory available for work space.	Abort job	M01

ST05,xxxxxx	OPEN error on file xxxxxx	Abort job	D01,H06
ST06,xxxxxx	I/O error on file xxxxxx	Abort job	H06
ST07,xxxxxx	Attempt to write past end-of-file xxxxxx. (Work file or output file too small.)	Abort job	D32

A.12 DATAPLOT

Message	**Condition**	**Action**	**Possible User Action**
DP00,xxxxxx	Plot file overflow	Incomplete plot	D30
DP01,xxxxxx	Buffer overflow	Incomplete plot	M05
DP02,xxxxxx	Attempted to plot from unsorted plot file	Abort plot	P20
DP03,xxxxxx	End-of-file detected before end-of-plot indicator	Incomplete plot	P07
DP04,xxxxxx	Minimum/maximum x or y value exceeded	Line will follow plot boundary, origin will be shifted	P21
DP05,xxxxxx	PLOTS not called	Abort plot	P22
DP06,xxxxxx	Data Plot I/O error	Abort task xxxxxx	H06,H05
DP07,xxxxxx	Attempted to sort from a non-RMD media	Abort task	D31

where xxxxxx is the task name.

A.13 SUPPORT LIBRARY

There are no error messages unique to this section of the manual.

A.14 REAL-TIME PROGRAMMING

There are no error messages unique to this section of the manual.

A.15 SYSTEM GENERATION

RECORD-INPUT ERRORS: Errors in input record found before processing.

Message	Condition	Action	Possible User Action
SG00	Read error (I/O)	Waits for corrected input	P19,D11
SG01	Syntax error in SGEN directive	Waits for corrected input	D01,D11
SG02	Invalid or missing parameter in SGEN directive	Waits for corrected input	D01,D11
SG03	Syntax error in control record	Waits for corrected input	D11
SG04	Invalid or missing parameter in control record	Waits for corrected input	D01,D11
SG05	Binary-object check sum error	Waits for corrected input	P08,D11
SG06	Binary-object sequence error	Waits for corrected input	P08,D11
SG07	Binary-object record code error	Waits for corrected input	P08,D11
SG08	Unexpected end of file, end of device, or beginning of device	Waits for corrected input	P07,D11

SG09	Improper ordering of load-module-package control records	Waits for corrected input	D11

OUTPUT ERRORS: Errors in the attempt to perform I/O on an RMD or listing unit.

Message	**Condition**	**Action**	**Possible User Action**
SG10	RMD I/O error in directive processor	Waits for indicated corrective action	D12
SG11	RMD I/O error in nucleus processor	Waits for indicated corrective action	D12
SG12	RMD I/O error during library generation	Waits for indicated corrective action	D12
SG13	RMD I/O error during resident-task generation	Waits for indicated corrective action	D12
SG14	First track on RMD bad (unable to write PST/ bad-track table)	Waits for indicated corrective action	D12
SG15	Write error on listing device	Waits for indicated corrective action	None

SYSTEM-GENERATOR PROCESSING ERRORS: Errors preventing the correct functioning of the system generator.

Message	**Condition**	**Action**	**Possible User Action**
SG20	Requested SGEN driver not available	System halts	M05,D22,D18, D15
SG21	Loading error in directive processor	Waits for indicated corrective action	D12

SG22	Loading error in nucleus processor	Waits for indicated corrective action	D12
SG23	Loading error in library processor/ resident-task configurator	Waits for indicated corrective action	D12
SG24	Stacks exceed available memory	Waits for indicated corrective action	M03,D12
SG25	Incomplete system definition (missing directives)	Waits for indicated corrective action	D01,D12
SG26	RMD error (too many sectors allocated, or nonsequential partition assignments)	Waits for indicated corrective action	D01,D25.D12
SG27	Error while loading SGEN loader, I/O control, or drivers. Driver not found in SGL	System halts	D15
SG28,xx	Error while loading SGEN component xx = 05 - checksum 06 - sequence 07 - record 21 - other in SGEN1 22 - other in SGEN2 23 - other in SGEN3 24 - other in SGEN4	Waits for indicated corrective action	P08,D12

MEMORY ERRORS: Errors of compatibility between allocated memory and a portion of the VORTEX system.

Message	**Condition**	**Action**	**Possible User Action**
SG30	Size of nucleus larger than that of defined foreground area	Waits for indicated corrective action	M03.D12
SG31	Load-module literal pool overflow	Current load module processing terminated, system continues	P09,D17

SG32	Size of load module larger than defined memory area	Current load module processing terminated, system continues	M03,P02,D17
SG33	Invalid definition of common during load-module generation	Current load module processing terminated, system continues	M03,D17
SG34	Number of overlays input not the same as specified by TID control record	Current load module processing terminated, system continues	D01,D17

SYSTEM LOADING AND LINKING ERRORS: Errors that prevent normal loading or linking of system components.

Message	Condition	Action	Possible User Action
SG40	Loader code error in library processor	Current load module processing terminated, system continues	P08,D17
SG41	Loaded program contains no entry name	Current load module processing terminated, system continues	P08,D17
SG42	Unsatisfied external in library processor	Current load module processing terminated, system continues	P10,D17
SG43	No execution address found in root segment or overlay	Processing continues. Address defaults to the first location of the program	P11
SG44	Loader code error in nucleus processor (i.e., indirect or literal in foreground task)	Waits for indicated corrective action	P08,D12,

SG45	Unsatisfied external in nucleus processor	Waits for indicated corrective action	P10,D12
SG46	System peripheral assigned to more than one logical-unit class	Waits for indicated corrective action	D12

A.16 SYSTEM MAINTENANCE

Message	**Condition**	**Action**	**Possible User Action**
SM01	Invalid SMAIN directive	Ignore directive	D01,D02
SM02	Record not recognized	Ignore directive	P19,D10
SM03	Check-sum error in object module	Waits for indicated corrective action	P08,D10
SM04	Incorrect size of object-module record (correct: 120 words for RMD input, otherwise 60 words)	Waits for indicated corrective action	P12,D10
SM05	Loader code error in object module	Waits for indicated corrective action	P08,D10
SM06	Sequence error in object module	Waits for indicated corrective action	P08,D10
SM07	Object module contains non-object-module text record	Waits for indicated corrective action	P12,D10
SM08	Error or end of device received after reading operation	Waits for indicated corrective action	P07,D10
SM09	Error or end of device received after writing operation	Waits for indicated corrective action	P07,D10

SM10	Stack area full	Waits for indicated corrective action	M01
SM11	Invalid control record	Waits for indicated corrective action	P19,D10

A.17 OPERATOR COMMUNICATION

Message	Condition	Action	Possible User Action
OC01	Request type error	Ignore directive	D01,D02
OC02	Parameter limits exceeded	Ignore directive	D01,D02
OC03	Missing parameter	Ignore directive	D01,D02
OC04	Unknown or undefined parameter	Ignore directive	D01,D02
OC05	Attempt to schedule or time schedule OPCOM task	Ignore directive	D01,D02
OC06	Attempt to declare OC device or system resident unit down	Ignore directive	D01,D02
OC07	Task specified in TSTAT key-in has no established TIDB, task currently not active	Ignore directive	D01,D02
OC10	Attempt to assign unit declared down or assign an unassignable logical unit/device	Ignore directive	D19,H04
OC11	Attempt to allocate TIDB unsuccessful for TSCHED request	Ignore directive	M02

A.18 RMD ANALYSIS AND INITIALIZATION

Message	Condition	Action	Possible User Action
RZ01	Invalid RAZI directive or illegal separator or terminator	Ignore directive	D01,D11

RZ02	Invalid parameter in a RAZI directive	Ignore directive	D01,D11
RZ03	Insufficient or conflicting directive information	Ignore directive	D01,D11
RZ04	New PST incompatible with the system	Ignore directive	D20,D21,D22, D11
RZ05	Named device cannot be replaced (system RMD or device busy)	Ignore directive	D01,D11
RZ06	Irrecoverable I/O error on designated RMD	Ignore directive	H06,D11
RZ07	First track of disc pack bad (pack unusable)	Ignore directive	D24
RZ08	Directive incompatible with specified RMD	Ignore directive	D25,D23
RZ09	Irrecoverable I/O error on system RMD (VORTEX nucleus)	Ignore directive	H06,D11
RZ10	I/O error on LO device	Ignore directive	D11,H06
RZ11	I/O error on SI device	Ignore directive	D11,H06
RZ12	No memory available to allocate for new bad-track table	RAZI aborted	M02
RZ13	Total number of tracks specified in PRT directive exceeds size of the device or is incompatible with the FRM directive	Ignore directive	D25,D11

A.19 PROCESS INPUT/OUTPUT

There are no error messages unique to this section of the manual.

A.20 WRITABLE CONTROL STORE

A.20.1 Microprogram Assembler

During assembly the symbolic statements are checked for syntactic errors. In addition, a condition may occur where the assembler is unable to determine the correct meaning of the symbolic source statements.

Either case is indicated as an error and up to eight error codes will be output beneath the source statement incorrectly constructed.

NR, LC and IO errors terminate the assembly.

Each error code with the exception of IO is followed by a space and two decimal digits indicating the character position the assembler was scanning when the error was detected.

The error codes and their meanings are listed below:

Error Code	Meaning
AD	Address expression or associated fields in error
CC	Continuation not expected
CE	Numeric conversion error
DD	Illegal redefinition of a symbol
ER	Syntax error
EX	An expression contained an illegal construction
FN	Field number inconsistent with format
IO	I/O error
LC	Program location counter setting exceeds the maximum WCS page size (512 words)
MF	Duplicate field reference
NR	No memory available for addition of an entry to assembler's tables
NS	No symbol in the label field where required
OP	Operation field undefined
SE	Symbol in label field has a value during pass 2 that is different from the value determined in pass 1
Sy	Undefined symbol. A value of zero is assumed
SZ	A value too large for the size of a field, or the fields defined in a format statement do not equal 64 bits

A.20.2 Microprogram Simulator

Message	Condition	Action	Possible User Action
MS01	Input could not be interpreted as a valid command	Directive ignored; input recovery*	D01,D02
MS02	A non-hex character was encountered when hex expected	Directive ignored; input recovery*	D02,D02
MS03	Insufficient common area to contain specified number of pages	Request for highest page repeated	M01,D26
MS04	The selected page number was not valid	Directive ignored; input recovery*	D26
MS05	An attempt was made to jump to an unavailable WCS page	Simulation halted	P13
MS06	A BCS instruction was encountered when WCS page 1 is unavailable	Simulation halted	D26,P13
MS07	Read error on BI device	Loading aborted	H06
MS08	EOF encountered before load complete	Loading aborted	P07

MS09	EOD/BEOD encountered before load complete	Loading aborted	P08
MS10	Sequence error on BI	Loading aborted	P08
MS11	Invalid loader code	Loading aborted	P08
MS12	Checksum error	Loading aborted	P08
MS13	Undefined macro opcode	Simulation continues	P15
MS14	Attempted to write to memory outside defined main memory	Simulation continues	P16
MS15	Attempted to load outside main memory	Loading aborted	P23
MS16	Invalid field name	Remainder of directive ignored	D01
MS17	Invalid field value	Remainder of directive ignored	D01

* Input recovery message or corrected directive from SO device.

A.20.3 Microprogram Utility

Message	**Condition**	**Action**	**Possible User Action**
MU01	Input could not be interpreted as a valid command	Directive ignored; input recovery*	D01,D02
MU02	A non-hex character was encountered when hex expected	Directive ignored; input recovery*	D01,D02
MU03	EOF detected on SI	Microprogram utility aborted	P07

MU04	The selected page number was not valid	Directive ignored; input recovery*	D01,D02
MU05	Unable to access WCS: WCS is busy	Directive ignored	H05
MU06	Unable to access WCS: BIC load in progress	Directive ignored	H05
MU07	Read error on BID device	Loading aborted	H06
MU08	EOF encountered before load complete	Loading aborted	P07
MU09	EOD/BOD encountered before load complete	Loading aborted	P08
MU10	Sequence error on BI	Loading aborted	P08
MU11	Invalid loader code	Loading aborted	P08
MU12	Checksum error	Loading aborted	P08

* Input recovery message or corrected directive from SO device.

A.21 VTAM NETWORK CONTROL MODULE

The VTAM network control module (NCM) generates the following error messages:

Message	**Condition**	**Action**	**Possible User Action**
NC01	Syntax error	Ignore directive	D01,D02
NC02	Undefined line	Ignore directive	D27,D02
NC03	Undefined TUID	Ignore directive	D27,D02
NC04	I/O error on file VT$DFL	Ignore directive	H06,D02
NC05	I/O error on file VT$DFT	Ignore directive	H06,D02
NC06	Undefined CCM number	Ignore directive	D27,D02

A.22 FILE MAINTENANCE UTILITY (FMUTIL) ERRORS

Message	Condition	Action	Possible User Action
END-OF-FILE	This is an ERROR MSG meaning an END-OF-FILE was encountered before the specified request could be completed.	FMUTIL Process Terminated	D01,P07
A DIRECTORY STRUCTURE ERROR-LUN lun SECTOR-sector num	A = blanks lun = 4 digits giving logical unit number sector num = 7 digits giving the sector number in error. This is an ERROR MSG. Meaning there is a structure error in the object module.	FMUTIL Process Terminated	H06
FILENAME ERROR	INVALID filename or filename not found	No action taken error output and ignored goes to next entry	D01.D02. D03
DIRECTORY ERROR ERROR · · Beg. · · end · eof · · current · end · eof.	Directory error shows writing over the directory by direct addressing of an RMD partition. · = blanks Beg = 2 digits showing beginning sector addr. end = 2 digits showing the ending sector addr eof = 2 digits showing end-of-file addr. current = 7 digits showing current beg addr. end = 7 digits showing ending addr. of current sector. eof = 7 digits showing current eof.	FMUTIL Process Terminated	P17
TAPE INPUT ERROR	READ ERROR (file Header not found)	Outputs error tries again.	D01.D07. D11
PARTITION OVERFLOW	Insufficient space for entry into partition	Module not added, outputs last directory sector.	D07.D09. D01.D03
INSUFFICIENT SPACE IN PARTITION	Insufficient space for entry	File not added. FMUTIL process terminated	H06.M01

Message	Condition	Action	Possible User Action
FMAIN ERROR-	4 blanks and 1 digit reference to FMAIN ERROR indicated required I/O error.	Outputs msg. FMUTIL process terminated, depending upon error mentioned.	H06
CAPACITY EXCEEDED	Insufficient space for entry to Directory.	Sorts entries in alphabetical order, and outputs listing.	M01
PARTITION SIZE sze SECTORS . . . . . num ARE UNASSIGNED	Partition size and sectors as stated in error message have not been assigned. . = blanks size = 7 digits showing size of partition. num = 5 digits showing number of sectors unassigned.	Returns to try again.	P17,H06

A.23 COMSY ERROR MESSAGES

The following are the COMSY error numbers and associated types of errors detected:

Error	Definition
1	Directive not understood.
2	Missing directive.
3	Input was not .COMSY or .FILE when searching for a named COMSY deck on PI
4	Record sequence error on binary COMSY input.
5	Record checksum error on binary COMSY input
6	Parameter list in error.
7	Missing .COMSY directive on PI.
8	Updates were not terminated by a .COMSY directive
9	Sequence number greater than 99999 on an update directive.
10	Update sequence numbers not ascending.
11	.COMSY deck specified, not on COMSY file on PI.
12	Incorrect unit.
14	Common decks limited to 19.
15	Common deck not found.
16	Update directive not understood.
17	I/O error.
18	Erroneous end-of-file condition.
19	Directory error on a random file.

A.24 ERROR CODES

A.24.1 Errors Related to Directives

D01 Check spelling, delimiters, and parameters.

D02 Enter corrected request from OC or SO.

D03 Check specified library for module name (FMAIN list).

D04 Correct task priority.

D05 Check PIM directives used at system generation.

D06 Use a global logical unit in directive.

D07 Use an alternate library or unit.

D08 Increase library size with RAZI or during SGEN.

D09 Delete unused modules from library.

D10 Reposition record if PT or CR (for MT or RMD positioning is automatic and enter on SO:

R@ to reread the record or   where @ is a
P@ to reread the program or   carriage return
/SMAIN@ to restart SMAIN

D11 Correct input record by entering it on SO or indicate that it is positioned for rereading by entering C on SO.

D12 Restart component by entering C on SO. (Repositioning is automatic for MT and RMD, for cards reload the entire deck and SGEN will find component.)

D13 SGEN requesting bad track analysis for unformatted RMDs or reformat formatted RMDs.

D14 Restart SGEN from beginning.

D15 Check spelling, delimiters, etc. of IO INTEROGATION.

D16 Correct appropriate SGEN directives as indicated.

D17 Correct indicated module for next SGEN or add corrected module with LMGEN after SGEN completes.

D18 Check that all RMDs are included in the SYS directive that are indicated by the EQUIP directives.

D19 Use OPCOM IOLIST for unit to check unit status (up or down) and unit's logical group.

D20 Check PRT directive.

D21 Check if maximum number of partitions specified in EDR directive has been exceeded.

D22 Check for conflicts in controller/unit relations.

D23 Check logical unit in directive, must be assigned to first partition of the subject RMD unit.

D24 The specified RMD pack cannot contain a bad track table due to the first track being bad, use another pack.

D25 Check FRM directive and total number of tracks specified in PRT directive. The following table gives the track capacity for the standard RMDs:

70-75XX	4060 tracks
70-76X0	203 tracks
70-76X3	406 tracks
70-7701	128 tracks
70-7702	256 tracks
70-7703	512 tracks

D26 Check response to the highest page number requested.

D27 Check NDM definition or use LIST directive of NCM.

D28 Use NCM module to check line/terminal status.

D29 Check that all subject logical units assigned to RMD have been positioned with a PFILE.

D30 Use a larger file for the plot file.

D31 Check for proper logical unit (i.e., IOLIST).

D32 Increase work file xxxxxx size.

D33 Check type parameter on TIDB directive

A.24.2 Errors Related to Programs

P01 Correct request in requesting task and re-execute.

P02 Recode task using overlays.

P03 Check for privileged or illegal instruction at specified location. Check listings or check memory by requesting a dump.

P04 Check FCB or DCB entries.

P05 Check for proper read mode, packed or unpacked.

P06 Check for needed global files such as PO, SS, GO, SW. Note: the diagnostic gives the task name and not necessarily the missing file name.

P07 Check source for an erraneous EOF, END directive, etc.

P08 Check module for the indicated error;
sequence number word 1, bits 0-7
checksum value word 2
Note: binary records can be listed using the DUMP directive of IOUTIL.

P09 Check $LIT and $IAP values from the load module map.

P10 Examine map for missing externals and make necessary program changes.

P11 Check for an execution label on the END statement of the source. Note: this is a normal diagnostic for FORTRAN overlays

P12 Check for a non-binary record or a short or long record in the module. The record length can be found in word 5 of the request block upon completion of I/O.

P13 Check code and continue after making corrections as indicated.

P14 Check requested page number.

P15 Check opcode for valid instruction.

P16 Check memory address, store request is ignored.

P17 Check for specified instruction or operation at location indicated in error message. Note: the address indicated refers to the instruction causing the error and not the violated address.

P18 Check the page status: read/write, read only, fetch operand only, or unassigned.

P19 Check for illegal data under current mode, i.e., binary in ASCII record, non-binary in binary record.

P20 Sort the plot file.

P21 This may be an intentional message. Plot continues.

P22 Call PLOTS.

P23 Check memory address, check ORG value and load range

P24 Recode into multi tasks or use fewer overlays

A.24.3 Errors Related to Memory Size

M01 If background, adjust MEM directive as needed.

M02 Wait for foreground tasks to release memory or TIDB space.

M03 If MEM request OK or cannot be increased then cut back on foreground common, empty TIDBs, reentry stack size, peripheral drivers, etc. by re-SGEN.

M04 If sharing blank common and VTAM LCB area, check that a program has not used part of the LCB area.

M05 Increase buffer area with BSS or dimension commands.

M06 Increase reentry stack size in SGEN EDR directive.

A.24.4 Errors Related to Hardware

H01 Make indicated unit ready.

H02 Clear the protection of the unit. (Disc write protection or write ring in MT).

H03 ABORT task, reassign SI if necessary, and then declare device down through OPCOM, do not forget to declare it back up again.

H04 ABORT task and assign alternate device or declare device back up.

H05 Check hardware for indicated problem.

H06 Check the OC device for an IO error message, i.e., IOxx.

APPENDIX B
I/O DEVICE RELATIONSHIPS

			Allowable Functions by I/O Device Type				
Function	RMD	MT	PT	CR	CP	LP	TY or CRT
Read binary record	X	X	X	X			X^{4}
Read alphanumeric record	X^{1}	X	X	X			X
Read BCD record	X^{1}	X	X^{2}	X^{2}			X^{4}
Read unformatted record	X^{1}	X^{1}	X	X			X^{4}
Write binary record	X	X	X		X	X^{9}	X^{4}
Write alphanumeric record	X^{1}	X	X		X^{3}	X	X
Write BCD record	X^{1}	X	X^{2}		X^{2}	X^{9}	X^{4}
Write unformatted record	X^{1}	X^{1}	X		X	X^{9,10}	X^{4}
Write end of file		X	X		X		X^{8}
Rewind unit	X	X	X^{3}	X			
Skip one record forward	X	X					
Skip one record backward	X	X					
Perform function zero			X^{3}		X^{3}	X^{5}	X^{5}
Perform function one						X^{6}	X^{6}
Perform function two						X^{7}	X^{7}
Open a file with rewind option	X	X					
Open a file with leave option	X	X					
Close a file with leave option	X	X					
Close a file with update option	X	X					

NOTES

(1) All modes are read/written in binary mode.

(2) BCD mode is handled like unformatted mode.

(3) Punch 256 frames of leader on paper tape or eject one blank card on card punch.

(4) All modes are written in alphanumeric mode.

(5) Advances paper to top of form on line printer, or causes carriage return and feeds three lines on Teletype or CRT.

(6) Advances paper one line.

(7) Advances paper two lines.

(8) Rings bell on Teletype or beeps on CRT.

(9) 620-77 line printer -- All modes are treated as alphanumeric.

(10) 620-76 printer/plotter -- Unformatted records are transmitted without interpretation as plot data.

I/O Errors by I/O Device Type

					I/O Device			
Code	Description	RMD	MT	PT	CR	CP	LP	TY or CRT
000	Unit not ready	X	X	X	X	X	X	X
001	Device down	O	O	O	O	O	O	X
002	Illegal LUN specified	O	O	O	O	O	O	O
003	FCB/DCB parameter error	O	O	O	O	O	O	O
004	Level 0 program references a protected partition	O	O	O	O	O	O	O
005	Level 0 program references protected memory	O	O	O	O	O	O	O
006	I/O request error	O	O	O	O	O	O	O
007	Read request to write only device, or vise versa				O	O	O	
010	File name not found	X						
011	File extent error	X						
012	RMD directory error	X						
013	Level 0 program read a JCP (/) directive on SI	O	O	O	O			
014	Interrupt time out	X	X	X				
015	RMD cylinder-search or malfunction error	X						
016	RMD read/write timing error	X						
017	RMD address error	X						
02n	BICn error	X	X		X	X	X	
030	Parity error	X	X					
031	Reading error by card reader or paper tape device			X	X			
032	Odd-length record error		X					

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X = Error reported by I/O drivers.

O = Error reported by I/O control processor.

APPENDIX C
DATA FORMATS

This appendix explains the formats and symbols used by VORTEX for storing information on paper tape, cards, and magnetic tape.

C.1 PAPER TAPE

Information stored on paper tape is binary, alphanumeric, or unformatted. It is separated into records (blocks of words) by three blank frames. The last frame of each record contains an end-of-record mark (1-3-4-8 punch).

C.1.1 Binary Mode

Binary information is stored with three frames per computer word (figure C-1). Note that channels 6 and 7 are always punched.

C.1.2 Alphanumeric Mode

Alphanumeric information is stored with one frame per character (figure C-2). Standard ASCII-8 punch levels are used.

C.1.3 Unformatted Mode

The tape is handled as for alphanumeric mode, but without validity-checking.

C.1.4 Special Characters

An end of file is represented by the ASCII-8 BELL character (1-2-3-8 punch).

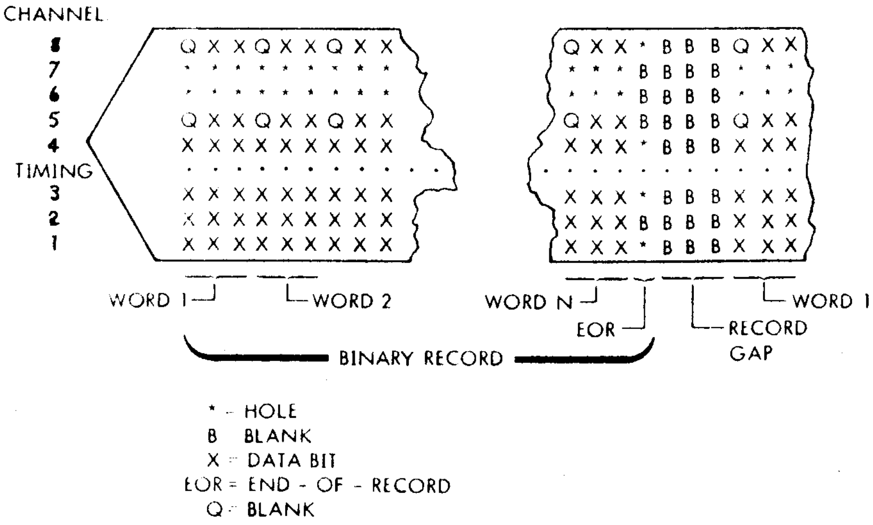

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Figure C-1. Paper Tape Binary Record Format

When paper tape is punched on a Teletype, the ASCII-8 ERROR character flags erroneous frames punched by the Teletype when it is turned on or off. This notifies the Teletype and paper tape reader drivers to ignore the next frame.

When alphanumeric input tapes are punched off-line on a Teletype, there is no means of spacing the three blank frames after every record. The following procedure gives a tape that can be read by the paper-tape reader driver:

a. Punch the alphanumeric statement.

b. Punch an end of record (RETURN on the Teletype keyboard).

c. Punch three or more frames containing any of the following characters:

Press CONTROL and:	ASCII-8 Equivalent
@	DCO
LINE FEED	LINE FEED
WRU	WRU
EOT	EOT
RU	RU
VT	VTAB
TAB	HTAB
HERE IS (33 ASR only)	NULL

NOTE

Any of these characters can also be used for leader and trailer.

d. Punch the next alphanumeric statement. Return to step b.

C.2 CARDS

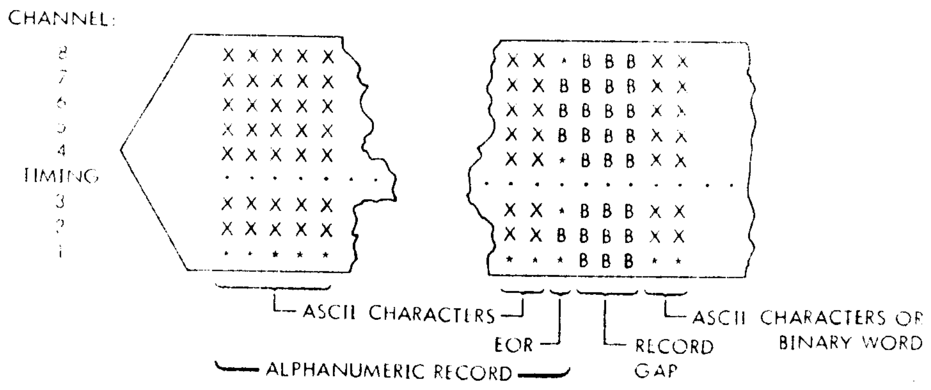
Information stored on cards in binary, alphanumeric, or unformatted. Each card holds one record of information. Hence, there is no end-of-record character for cards.

C.2.1 Binary Mode

Binary information is stored with sixty 16-bit words per card. The information is serial with bit 15 of the first word in row 12 of column 1, bit 14 in row 11, etc. (figure C-3). Any 11-0 punch in column 1 is treated as binary.

C.2.2 Alphanumeric Mode

Alphanumeric information is stored one character per card column (figure C-4) using the standard punch patterns



* = HOLE FOR ASCII CHARACTER OR DATA BIT FOR BINARY INFORMATION
B = BLANK
X = DATA BIT
EOR = END-OF-RECORD

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Figure C-2. Paper Tape Alphanumeric Record Format

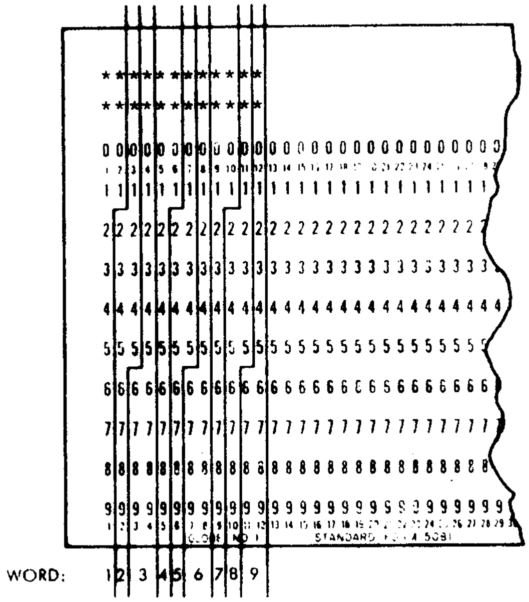

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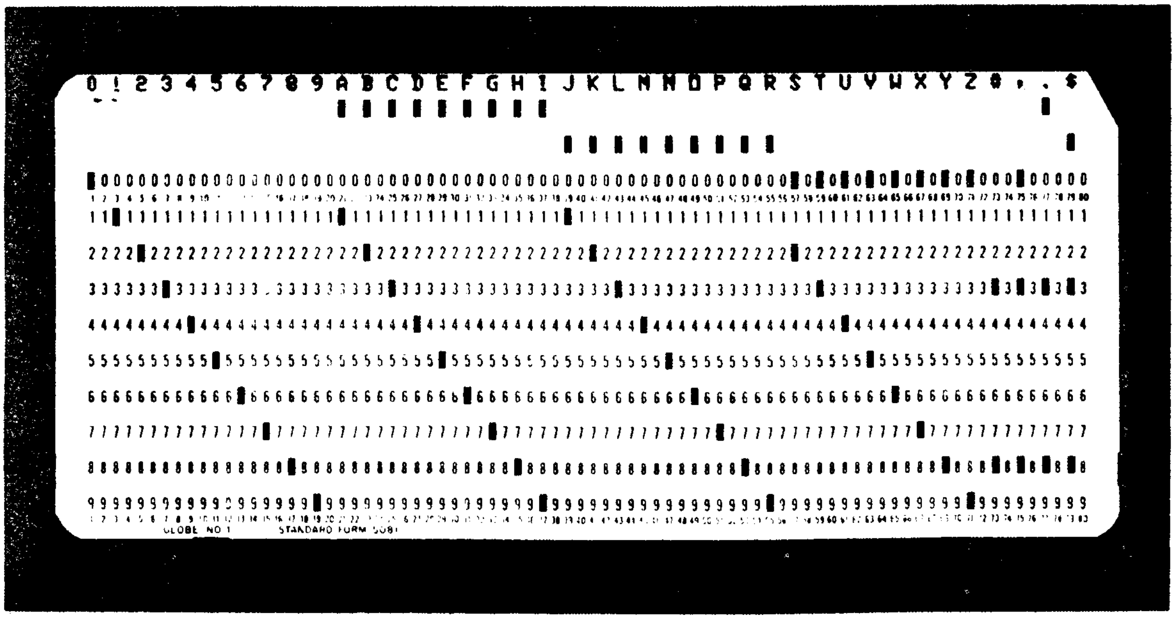
Figure C-3. Card Binary Record Format


0 1 2 3 4 5 6 7 8 9 A B C D E F G H I J K L M N O P Q R S T U V W X Y Z @ , . $
GLOBE NO 1
STANDARD FORM 5081

VTII-0957

Figure C-4. Card Alphanumeric Record Format (IBM 026)

C.2.3 Unformatted Mode

The data are handled, one column per computer word, right-justified, and without validity-checking.

C.2.4 Special Character

An end of file is represented on cards by a 2-7-8-9 punch in column 1 of an otherwise blank card.

C.3 MAGNETIC TAPE

Information stored on seven-track magnetic tape is either binary or BCD. On nine-track tape, information is always binary.

C.3.1 Seven-Track

For system-binary, ASCII, and unformatted modes, the first frame is read into bits 15-12 of the word, the second frame into bits 11-6, and the third into bits 5-0. For BCD mode, the first frame is read into bits 11-6 and the second into bits 5-0.

C.3.2 Nine-Track

In all modes, the first frame is read into bits 15-8 of the word, and the second frame into bits 7-0.

C.4 STATOS PRINTER/PLOTTER

Information may be output to the Statos printer/plotter in alphanumeric and unformatted modes.

C.4.1 Alphanumeric Mode

Information output in alphanumeric mode is assumed to be ASCII characters packed two to a word. Each character is converted to a dot matrix and the print line is transmitted to the device. Characters may be printed in two sizes. The normal print size consists of a 7 by 11 dot matrix and allows 140 characters per line. The large size print consists of a 14 by 22 dot matrix and allows 70 characters per line. Excess characters will be truncated.

C.4.2 Unformatted Mode

Information output in unformatted mode is assumed to be plot data. The information is truncated after n words and transmitted to the device without conversion. Each 1 bit transmitted will cause a dot to be printed on the output line. The most significant bit of the first word is transmitted to represent the left-hand dot position on the line.

"n" depends on the bed width of the plotter. See section 20.3.3 for specific value.

APPENDIX D
STANDARD CHARACTER CODES

IBM 026 Punch			IBM 029 Punch	
Symbol	ASCII	Hollerith	ASCII	Symbol
!	375	11-0	242	"
>	276	6-8	275	=
:	272	5-8	247	'
'	247	4-8	300	@
=	275	3-8	243	#
–	337	2-8	272	:
9	271	9	271	9
8	270	8	270	8
7	267	7	267	7
6	266	6	266	6
5	265	5	265	5
4	264	4	264	4
3	263	3	263	3
2	262	2	262	2
1	261	1	261	1
(blank)	240	(blank)	240	(blank)
&	246	11-0	375	!
<	274	12-6-8	253	+
[	333	12-5-8	250	(
)	251	12-4-8	274	<
.	256	12-3-8	256	.
	277	12-2-8	333	[
I	311	12-9	311	I
H	310	12-8	310	H
G	307	12-7	307	G
F	306	12-6	306	F
E	305	12-5	305	E
D	304	12-4	304	D
C	303	12-3	303	C
B	302	12-2	302	B
A	301	12-1	301	A
+	253	12	246	&
	245	11-7-8	334	\
;	273	11-6-8	273	;
]	335	11-5-8	251	)
*	252	11-4-8	252	*
$	244	11-3-8	244	$
	241	11-2-8	241	
R	322	11-9	322	R
Q	321	11-8	321	Q
P	320	11-7	320	P
O	317	11-6	317	O
N	316	11-5	316	N
M	315	11-4	315	M
L	314	11-3	314	L
K	313	11-2	313	K
J	312	11-1	312	J
-	255	11	255	-
#	243	0-7-8	277	?
\	334	0-6-8	276	>
"	242	0-5-8	337	
(	250	0-4-8	245	%

STANDARD CHARACTER CODES

IBM 026 Punch Symbol	ASCII	Hollerith	IBM 029 Punch ASCII	Symbol
.	254	0-3-8	254	.
@	300	0-2-8	335	]
Z	332	0-9	332	Z
Y	331	0-8	331	Y
X	330	0-7	330	X
W	327	0-6	327	W
V	326	0-5	326	V
U	325	0-4	325	U
T	324	0-3	324	T
S	323	0-2	323	S
/	257	0-1	257	/
0	260	0	260	0

APPENDIX E
ASCII CHARACTER CODES

Character	Internal ASCII	Character	Internal ASCII
0	260	R	322
1	261	S	323
2	262	T	324
3	263	U	325
4	264	V	326
5	265	W	327
6	266	X	330
7	267	Y	331
8	270	Z	332
9	271	(blank)	240
A	301		241
B	302	"	242
C	303	#	243
D	304	$	244
E	305		245
F	306	&	246
G	307	'	247
H	310	(	250
I	311	)	251
J	312	*	252
K	313	+	253
L	314	,	254
M	315	-	255
N	316	.	256
O	317	/	257
P	320	:	272
Q	321	;	273
<	274	FORM	214
=	275	RETURN	215
>	276	SO	216
	277	SI	217
@	300	DCO	220
	333	X-ON	221
	334	TAPE AUX	
	335	ON	222
'	375	X-OFF	223
-	337	TAPE OFF	
RUBOUT	377	AUX	224
NUL	200	ERROR	225
SOM	201	SYNC	226
EOA	202	LEM	227
EOM	203	S0	230
EOT	204	S1	231
WRU	205	S2	232
RU	206	S3	233
BEL	207	S4	234
FE	210	S5	235
H TAB	211	S6	236
LINE FEED	212	S7	237
V TAB	213		

APPENDIX F
VORTEX HARDWARE CONFIGURATIONS

Device	Device Address	Interrupt	Interrupt Address	BIC	Comments
73-3300 Memory Map	046	MP halt error	020	n/a	Wired as system priority 1
		MP I/O error	022	n/a	
		MP write error	024	n/a	
		MP jump error	026	n/a	
		MP unassigned error	030	n/a	
		MP instruction fetch error	032	n/a	
		MP write and overflow error	034	n/a	
		MP jump and overflow error	036	n/a	
Power Failure/ Restart	···	Power failure	040	n/a	Wired as system priority 2
		Power restart	042	n/a	
Real-Time Clock	047	RTC variable interval	044	n/a	Wired as system priority 4 Base timer interval rate is 100 microseconds; free-running clock rate is 100 microseconds
		RTC overflow	046	n/a	
Priority Interrupt Module (PIM)	040-043		0100-0277	n/a	Wired as system priority 5; assignments should be from fastest to slowest Addresses 064-067 available for special use
Special PIM Instruction	044		n/a	n/a	PIMs modified to enable/disable with EXC 044
Buffer Interlace Controller (BIC) or Block Transfer Controller (BTC)	020-026 070-073	BIC complete	0100-0277	n/a	All wired as system priority 3 Addresses 070-073 available for BIC5 and BIC6 others created for special use

Device			Device Address	Interrupt	Interrupt Address	BIC	Comments
Disc Memory	70 7702 70 7703	620 47 48, 49 Drum 43C, D Disc Memory	014	BIC complete	0100 0277	Yes	RMD assigned to Highest system BIC (no other devices can be so assigned)
Disc Memory	70 7600 70 7610	620 37, 36 Disc Memory	016 017	BIC complete Cylinder search com plete	0100 0277 0100 0277	Yes	RMD assigned to highest system BIC (no other devices can be so assigned)
	70 7603 70 7613	Model F Disc Memory	015 017	BIC complete Cylinder search com plete	0100 0277 0100 0277	Yes	RMD assigned to highest system BIC (no other devices can be so assigned)
	70 7500	620 35 Disc Memory	015	BIC complete Cylinder search com plete	0100 0277 0100 0277	Yes	RMD assigned to highest system BTC (no other devices can be so assigned)
	70 7510	620 34 Disc Memory	015 017	BIC complete Cylinder search com plete	0100 0277 0100 0277	Yes	RMD assigned to highest system BTC (no other devices can be so assigned)
Magnetic Tape	70 7100	620 30 31A, 31B, or 31C, 32 Magnetic Tape Unit		Tape motion complete	0100 0277 0100 0277	Yes	
Card Reader	70 6200	620 25 Card Reader	030	BIC complete	0100 0277	Yes	
Printer/ Plotter	70 6602	620 75 Statos Printer/ plotter	035-036	BIC complete PC not busy	0100 0277	Yes	
		70-7702 70-660x Statos Printer/ Plotter	035-036	BIC complete PC not busy Statos not busy	0100 1077 0100 0277 0100 0277	Yes	Interrupt event words should be 01 for BIC, 02 for Statos, and 04 for PC
Line Printer		620 77 Line Printer	035 036	BIC complete	0100 0277	Yes	

Device			Device Address	Interrupt	Interrupt Address	BIC	Comments
Card Punch	70 6201	620-27 Card Punch	031	BIC complete	0100 0277	Yes	
Paper tape System	70-6320	620-55, -55A Paper Tape System	037,034	Character ready	0100-0277	No	
Teletype	70-6100 70-6104	620-6, -7, -8 Teletype	001-007	Read buffer ready Write buffer ready	0100-0277 0100-0277	No	Event 1 = READ Event 2 = WRITE
	70-6400	CRT with E-2184 Controller		Read buffer ready Write buffer ready	0100-0277 0100-0277	No	Compatible with Teletype (Event 1 = READ, Event 2 = WRITE)
		Front Panel			00-01	No	Wired as system priority 6; not used by VORTEX
	73-4000, -4001, -4002	070-074	n/a	n/a		No	Only one device address is used in a given system.
	WCS512 Words						Multiple WCS pages use the same device address

NOTES

(1) The priority look-ahead option is required if there are more than eight priority devices in the system.

(2) PIM assignments are arranged from the fastest devices to the slowest.

APPENDIX G
OBJECT MODULE FORMAT

Object modules generated by the VORTEX language processors result from assembly or compilation. The modules are input by the load-module generator and are bound together into a load module.

The first record of the module contains the size of the program, an eight-character identification, and an eight-character date. Entry name addresses, if any, appear as the first data field items of the object module.

G.1 RECORD STRUCTURE

Object-module records have a fixed length of sixty 16-bit words. Word 1 is the record control word. Word 2 contains the exclusive-OR check-sum of word 1 and words 3 to 60. Words 3 to 11 can contain a program identification block (optional). Words 12 to 60 (or 3 to 60 if there is no program identification block) contain data fields.

Table G-1 illustrates record control word formats.

G.2 PROGRAM IDENTIFICATION BLOCK

The program identification (ID) block appears in words 3 to 11 of the starting record of each module. Word 3 contains the program size, words 4 to 7 contain an ASCII eight-character program identification, from the TITLE statement, and words 8 to 11 contain an ASCII eight-character date.

G.3 DATA FIELD FORMATS

Data fields contain one-, two-, three-, or four-word entries. One-word entries consist of a control word; two-word entries consist of a control word and a data word; three-word entries consist of a control word and two data words, and four-word entries consist of a control word, two name words, and a data word. Data words can contain instructions, constants, chain addresses, entry addresses, and address offset values.

Table G-1. Record Control Word Format

Bit	Binary Value	Meaning
15	0	Verify check-sum
	1	Suppress check-sum
13-14	11	Binary record
	00-10	Nonbinary record
12	0	First record of module
	1	Not the first record
11	0	Last record of module
	1	Not the last record
10	0	
9	0	
8	0	Not a relocatable module (absolute)
	1	Relocatable module
0-7		Sequence number (modulo 256)

G.4 LOADER CODES

Loader codes, which have the following format, are among the data in an object module.

```
15     14  13  12    11  10  9    8  7  6        5  4  3       2  1  0
----------  -----------    --------------  ----------
    Code        Subcode           Pointer          Name
```

Code Values	Meaning
00	Refer to subcode for specific action.
01	Undefined.
02	Add the value of the selected pointer to the data word before loading.
03	Add the value of the selected pointer to the first data word (literal value) and enter the sum in the direct literal pool if bit 11 of the second data word is zero. Otherwise, enter it in the indirect literal pool. Add the address of the literal to the second data word before loading.

Code Values	Meaning
04	Load the data word(s) absolute. Bits 12 through 0 indicate the number of words minus one (n-1) to load.
05-07	Undefined.

Subcode Values	Meaning
00	Ignore this entry (one word only).
01	Set the loading address counter to the sum of the specified pointer plus the data word.
02	Chain the current loading address counter value to the chain whose last address is given by the sum of the selected pointer plus the data word. Stop chaining when an absolute zero address is encountered.
03	Complete the postprogram references by adding to each address the sum of the selected pointer plus the data word.
04-06	Undefined.
07	Set the program execution address to the sum of the values of the selected pointer plus the data word
010	Define the entry name with entry location as equal to the value of the selected pointer plus the data word.
011	Define a region for the pointer whose size is given in the data word. If the entry name is not blank, define the entry point as the base of the region.
012	Enter a load request for the external name. The chain address is given by the sum of the selected pointer plus the data word
013	Enter the loading address of the external name in the indirect literal pool. Add the address of the literal plus the value of the selected pointer to the data word (command) before loading
014-017	Undefined.

Pointer Values	Meaning
00	Program region.
01	Postprogram region.
02	Blank common region.
03-036	Labelled COMMON regions.
037	Absolute (no relocation).

Name Format

Names are one to six (six-bit) characters, starting in bit 3 of the control word and ending with bit 0 of the second name word. Only the right 16 bits of the two name words are used.

G.5 EXAMPLE

The following is a sample background program with the description of the object module format after the assembly and the core image after loading.

G.5.1 Source Module

```
                 NAME      SUBR
                 EXT       BBEN
     SUBR        ENTR
                 LDA*      SUBR
                 CALL      BBEN
                 STA       TIME
                 JAN       DONG
                 LDA       =2
                 CALL      BBEN
     DONG        INR       SUBR
                 JMP*      SUBR
     TIME        BSS       1
                 END
```

G.5.2 Object Module

160400	Record control word (first and last record, verify check sum sequence number 0)
157631	Check sum word.
	(Begin program ID block)
000016	Program size (exclusive of FORTRAN COMMON, literals and indirect address pointers)
142730 140715 150314 142640	Identification in ASCII (assume this program was labeled EXAMPLE)
131263 126661 130255 133271	Date of creation in ASCII (assume assembled 03 10 69)
	(End program ID block)
010000 000647 054262 000000	Define entry name SUBR at relative 0 (code [illegible] subcode 01 pointer 0, name SUBR, and data word 0)
100000 000000	Enter absolute data word 0 in memory at relative [illegible]
060000 100000 017000	Enter literal (indirectly addressed relative 0) in indirect pointer pool, add address of pointer to load 017000 and enter memory at relative 1
100000 002000	Enter absolute data word 02000 in memory at relative 2

```
100000     Enter absolute data word 000000 in memory at relative 3.
000000

100000     Enter absolute data word 054010 in men,ory at relative 4
054010

100000     Enter absolute data word 01004 in memory at relative 5.
001004

040000     Enter relative data word 012 in memory at relative 6.
000012

060760     Enter literal (absolute 2) into literal pool, add address of
000002     literal to load command 010000, and enter in memory at relative
010000     7.

100000     Enter absolute data word 02000 in memory at relative 010.
002000

040000     Enter relative data word 03 in memory at relative 011.
000003

060000     Enter literal (relative 0) into indirect pointer pool, add
000000     address of literal to increment command 047000, and enter in
047000     memory at relative 012.

100000     Enter absolute data word 01000 in memory at relative 013.
001000

040000     Enter relative data word 0100000 in memory at relative 014.
100000

001000     Set loading location for next command, if any, to relative
           016.

012003     Enter load request for external name BBEN and chain entry
000212     address to relative 011.
024556
000011
  •
  •
  •
  •
  •

           (The remaining words of this record contain zero).
```

G.5.3 Core Image

Assume the program originates at 01000, the literal pool limits are 0500-0777, and BBEN is loaded at 01016.

```
0500      101000    DATA     *01000
0501      001000    DATA     1000
 .
 .
 .
0777      000002    DATA     2
 .
 .
 .
01000     000000    ENTR     0
01001     017500    LDA*     0500    → ind. literal
01002     002000    JMPM
01003     001016             01016
01004     054010    STA      01015
01005     001004    JAN
01006     001012             01012
01007     010777    LDA      0777    → direct literal
01010     002000    JMPM
01011     001016             01016
01012     047501    INR*     0501    → ind literal
01013     001000    JMP
01014     101000           * 01000
01015               BSS      1
01016               BSS      1
```

The following six-bit codes are used by the load-module generator in building load modules. The codes define names created by NAME, TITLE, and EXT directives.

Character	Octal	Character	Octal	Character	Octal
@	40	V	66	+	13
A	41	W	67	,	14
B	42	X	70	-	15
C	43	Y	71	.	16
D	44	Z	72	/	17
E	45	[	73	0	20
F	46	\	74	1	21
G	47	]	75	2	22
H	50	↑	76	3	23
I	51	←	77	4	24
J	52	(blank)	00	5	25
K	53	!	01	6	26
L	54	"	02	7	27
M	55	#	03	8	30
N	56	$	04	9	31
O	57	%	05	:	32
P	60	&	06	;	33
Q	61	'	07	<	34
R	62	(	10	=	35
S	63	)	11	>	36
T	64	*	12	?	37
U	65				

G.6 END LOAD RECORD

An end-load-module record is used to terminate one or more object modules which comprise a root or sequent of a load module. This record is processed simularly to an end-of-file indication by LMGEN, however, more than one end-load-module record may be present on an RMD file.

new!

The form of an end-load-module record is a binary record in which the first word has the value 077000 and all other words are zero.